Radio Test Report

Zinwave Ltd

Uniwave Remote Unit

308-0007-1

47 CFR Part 22H Effective Date 1st October 2021
↳ 47CFR part 2J Effective Date 1st October 2021

Test Date: 21st March 2023 to 24th April 2023
Report Number: 04-14169-1-23 Issue 01

The testing was carried out by RN Electronics Ltd, an independent test house, at their test facility located at:

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Arnolds Court
Arnolds Farm Lane
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This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated April 2017).

File Name: Zinwave Ltd.14170-1 Issue 01

Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 14169-1

The equipment noted below has been tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 22H. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Uniwave Remote Unit
Model Number:	308-0007-1
Unique Serial Number:	810110000190
Applicant:	Zinwave Ltd Harston Mill, Royston Road Harston, Cambridge CB22 7GG
Proposed FCC ID	UPO308-0007-1
Full measurement results are detailed in Report Number:	04-14169-1-23 Issue 01
Test Standards:	47 CFR Part 22H Effective Date 1st October 2021 ↳ 47CFR part 2J Effective Date 1st October 2021

NOTE:
Certain tests were not performed based upon applicant's declarations. Certain other requirements are subject to applicant's declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test:	21st March 2023 to 24th April 2023
Test Engineer: Jack Chilvers	Jack Chilvers Digitally signed by: Jack Chilvers DN: CN = Jack Chilvers email = Jack.Chilvers@kiwa.com C = GB O = RN Electronics OU = RN Electronics Date: 2023.05.19 15:53:24 Z
Approved By: Radio Approvals Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2023.05.19 16:16:12 Z
Customer Representative:	

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1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Zinwave Ltd Harston Mill Royston Road Harston Cambridge CB22 7GG	
Manufacturer of EUT	Zinwave Ltd	
Full Name of EUT	Uniwave Remote Unit	
Model Number of EUT	308-0007-1	
Serial Number of EUT	810110000190	
Date Received	17th March 2023	
Date of Test:	21st March 2023 to 12th April 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	14th April 2023	
Main Function	Remote Unit in distributed antenna system. Takes RF over fibre and amplifies it before feeding to a wideband antenna.	
Information Specification	Height	70 mm
	Width	218 mm
	Depth	270 mm
	Weight	5.5 kg
	Voltage	48 VDC
	Current	0.85 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Wall Mounted
Choice of model(s) for type tests	Production Unit
Antenna details	Omnidirectional Ceiling Mounted - Laird/TE CFD69383P1 or Laird/TE CFS60383P (Gain: 5.2 dBi)
Antenna port	1 Tx port and 1 Rx port
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	894 MHz for this band of operation
Lowest Signal generated in EUT	11 MHz
Hardware Version (HVIN)	1
Software Version	5.21rc06 (Primary Hub)
Firmware Version (FVIN)	5.65 (EUT)
Type of Equipment	Booster, Distributed Antenna System
Technology Type	Various Cellular – wideband distributed antenna system
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	150-3980MHz Booster range (this band/report covers 869-894 MHz service band)
EUT Declared Modulation Parameters	Device supports Public Mobile Radios services under this rule part
EUT Declared Power level	+21 dBm
EUT Declared Signal Bandwidths	Device supports Public Mobile Radios services under this rule part
EUT Declared Channel Spacing's	Device supports Public Mobile Radios services under this rule part
EUT Declared Duty Cycle	up to 100%
Unmodulated carrier available?	Yes - EUT provides at its output whatever is presented to its input
Declared frequency stability	0ppm (DAS without frequency translation)
RX Parameters	
Alignment range – receiver	As per transmitter range
EUT Declared RX Signal Bandwidth	As per transmitter
Receiver Signal Level (RSL)	N/A
Method of Monitoring Receiver BER	N/A

2.3 Functional description

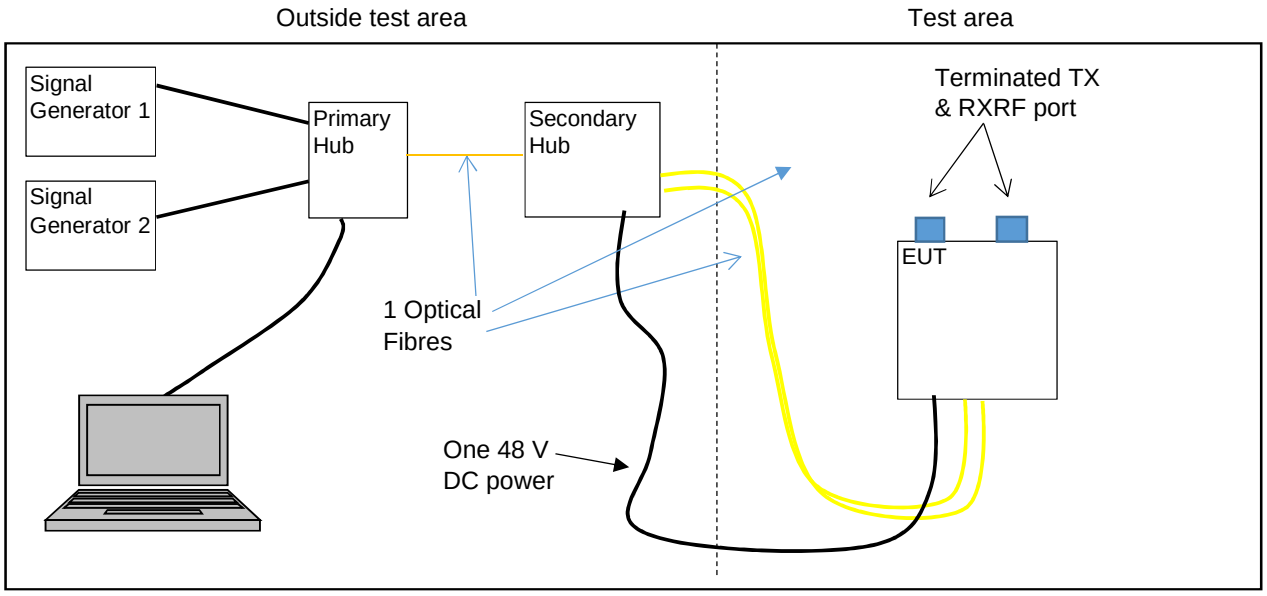
The Distributed Antenna System comprises a primary hub which accepts cellular base-station signals; this connects to 1 - 8 secondary hubs, each of which fan out the base-station signal to up to 8 Remote Units. The Remote Units require FCC certification since they are connected to a transmitting antenna.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	CW Sweep from 869-894 MHz to determine f0	Yes
Mode 2	Single mode Channel AWGN at f0 (891.5 MHz) in band 869-894 MHz	Yes
Mode 3	Single Low channel AWGN at 871.5 MHz	Yes
Mode 4	Single Mid channel AWGN at 881.5 MHz	Yes
Mode 5	Single High channel AWGN at 891.5 MHz	Yes
Mode 6	Dual Low channel AWGN at 871.5 MHz & 876.5 MHz	Yes
Mode 7	Dual High channel AWGN at 886.5 MHz & 891.5 MHz	Yes

Note: This report only pertains to the operation of the equipment to 47 CFR part 22, for details of testing to other rule parts please see RN reports: 04-14169-2-23 (Part 27) & 04-14169-3-23 (Part 96)

2.5 Emissions configuration



The EUT was powered from the secondary hub at 48V DC. The unit was configured using the supplied network management software using the settings files prepared by Zinwave Ltd. The unit provided either 24dB or 21 dB of gain, this was dependent on service band usage and single/dual channel usage. Target output power was set at +21dBm at the TX output port in conjunction with the signal generator settings. Any attenuation introduced by the Primary/secondary hub system was also accounted for in the set-up files provided by Zinwave Ltd. Test channels and required modulations were set using the signal generators connected to the primary hub. Single channel operation was provided by generator 1 and dual channel was using two signal generators. Output power of the signal generators was set to provide the target powers of the device under test.
The transmit mode was 100% continuous with EUT output power maintained at required target output power.
Test channels and combinations used are stated in test modes section 2.4
The system supports operation with a number of wideband services, so testing was performed with AWGN modulation signal as per KDB 935210 D05, and a CW signal for determination of f0.

For conducted RF tests the RF ports were connected via suitable attenuation and filtering where required and connected directly to a spectrum analyser, with losses accounted for in the measurement results.

The system is designed for operation with antennas having a maximum gain of 5.2 dBi or 3.06 dBd. This is the value used for determining EIRP or ERP where required.

2.5.1 Signal leads

Port Name	Cable Type	Connected
DC power 1	2 cores	Yes
Fibre TX 1	Fibre	Yes
Fibre RX 1	Fibre	Yes
Transmit port 1	N-type coaxial	Yes
Receive port 1	N-type coaxial	Yes

3 Summary of test results

The Uniwave Remote Unit, 308-0007-1 was tested for compliance to the following standard(s):

47 CFR Part 22H Effective Date 1st October 2021
↳ 47CFR part 2J Effective Date 1st October 2021

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. RF Power Output (ERP / EIRP)	47CFR part 2J Clause 2.1046, 47 CFR Part 22H Clause 22.913	PASSED
2. Occupied bandwidth	47CFR part 2J Clause 2.1049, 47 CFR Part 22H Clause 22.917	PASSED
3. Spurious emissions at antenna terminals	47CFR part 2J Clause 2.1051, 47 CFR Part 22H Clause 22.917	PASSED[1]
4. Band Edge compliance	47CFR part 2J Clause 2.1051, 47 CFR Part 22H Clause 22.917	PASSED
5. Field strength of spurious emissions	47CFR part 2J Clause 2.1053, 47 CFR Part 22H Clause 22.917	PASSED[1]
6. Frequency stability	47CFR part 2J Clause 2.1055, 47 CFR Part 22H Clause 22.355	NOT APPLICABLE[2]
7. Modulation Characteristics	47CFR part 2J Clause 2.1051	NOT TESTED[3]
8. Determination of f_0	KDB 935210 D05 Clause 3.3	PERFORMED

[1] Spectrum investigated started at a frequency of 30MHz up to a frequency of 9GHz based on 10 times the highest channel of 894 MHz for this service band.
[2] EUT does not contain an oscillator and only reproduces what is provided at its input.
[3] EUT uses digital modulation techniques. Modulation schemes and information is detailed in section 2.2 of this report.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 22H	2021	Part 22 Subpart H - Cellular Radiotelephone Service
4.1.2	47CFR part 2J	2021	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v03	2017	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement Guidance for Certification of Licensed Digital Transmitters
4.1.4	ANSI C63.26	2015	American National Standard for Compliance testing of transmitters used in Licensed radio services
4.1.5	KDB 662911 D01 v02r01	2013	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Emissions Testing of Transmitters with Multiple Outputs in the Same Band
4.1.6	KDB 935210 D05 v01r04	2020	Measurement guidance for industrial and Non-consumer signal Booster, Repeater and amplifier devices

4.2 Deviations

No Deviations have been applied.

5 Tests, methods and results

5.1 RF Power Output (ERP)

5.1.1 Test methods

Test Requirements:	47CFR part 2J Clause 2.1046 [Reference 4.1.2 of this report], 47 CFR Part 22H Clause 22.913 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.2 [Reference 4.1.4 of this report] KDB 935210 D05 Clause 3.5 [Reference 4.1.6 of this report]
Limits:	47 CFR Part 22H Clause 22.913 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was measured on a bench using a power meter & spectrum analyser connected to the external RF port. The EUT was operated in Mode 2 for this test.

5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section.
The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required and the frequency under test was set to an appropriate channel to include f_0 as determined in section 5.8. An Analyser was used to measure channel power over 5MHz BW using an RMS detector. CCDF function of the analyser was then used to determine Peak to Average Power Ratio.

Measurements were made in site N.

5.1.4 Test equipment

E558, H071

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Single channel	891.5 MHz (determined f0)

Test Instance (e.g. modulation or Resource block)	Average Cond Power (dBm) TX Chain 1	Antenna Gain dBi (dBd)	TX Power ERP (dBm)	TX Power ERP (W)	Power Limit (dBm)	Power Margin (dB)
AWGN at channel closest Fo	20.98	5.2 (3.06)	24.04	0.254	57	-32.96

Note: 5.2dBi Antenna gain (3.06dBd) is used. 891.5 MHz is the lowest 5MHz channel centre frequency within the band of operation and encompasses fo of 893.7075 MHz. Please refer to input/output plot for channel power measurement.

Peak to AV ratio (dB)	Plot reference	PK to AV Limit (dB)	PK to AV Margin (dB)
7.97	14169-1 891.5 MHz	13	-5.03

Any plots referred to in the above table may be found in section 6.

LIMITS:
Part 22H, 22.913(a) the ERP of base stations and repeaters must not exceed— 500W ERP.
Part 22.913 (d) The peak-to-average ratio (PAR) of the transmission must not exceed 13 dB.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.2 Occupied bandwidth / Input versus output signal

5.2.1 Test methods

Test Requirements:	47 CFR part 2J Clause 2.1049 [Reference 4.1.2 of this report],
Test Method:	ANSI C63.26 Clause 5.4 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.3 / 3.4 [Reference 4.1.5 of this report]
Limits:	None.

5.2.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was tested on the channel that encompassed the determined f0 in each applicable band. The EUT was operated in Mode 2.

5.2.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required and the frequency under test was set to an appropriate channel to include f_0 as determined in section 5.8. An RMS detector was set, and sweeps made comparing the 99% BW input and the output signals and their -26dBc BW points indicated on the plots taken. Tests were performed using Test Site N.

5.2.4 Test equipment

E558, H071

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Single channel	891.5 MHz (FO)

	Single channel
99 % Bandwidth (MHz) Nominal Temp & Volts	4.42
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts	891.5 MHz (channel closest to FO)
26 dB BW (MHz) Nominal Temp & Volts	4.58
Plot for 26 dB BW Bandwidth (MHz) Nominal Temp & Volts	891.5 MHz (channel closest to FO)

Analyser plots for bandwidth can be found in Section 6 of this report.

LIMITS:

Emissions to be contained within the applicable emissions mask/band edges.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.3 Spurious emissions at antenna terminals

5.3.1 Test methods

Test Requirements:	47CFR part 2J Clause 2.1051 [Reference 4.1.2 of this report], 47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.7 [Reference 4.1.4 of this report] KDB 935210 D05 Clause 3.6 [Reference 4.1.5 of this report]
Limits:	47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was tested across Low, Middle and High channels within the service band in a single channel input mode and in a dual channel input mode, modes tested were 3, 4, 5, 6 and 7.

5.3.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required. A complete scan of emissions from the lowest frequency generated/ used within the equipment up to 10 times the highest frequency generated/ used was made, to identify any signals within 20dB of the limits. Measurements were made and plots taken in the required Resolution bandwidths, where applicable results are referenced to EIRP limits by consideration of the antenna gain used with the EUT of 5.2dBi (3.06dBd) and indicated. Tests were performed in site N.

5.3.4 Test equipment

E558, E701, F030, F031, F931, H071

See Section 8 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Single Channel Results

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1743	-35.3	-22.3

Plots
CSE, Band 869-894 MHz, Single, 10MHz-869 MHz
CSE, Band 869-894 MHz, Single, 894 MHz-1 GHz
CSE, Band 869-894 MHz, Single, 1-10 GHz

Band	869-894 MHz

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Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low2 channel	881.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1763	-37.7	-24.7

Note: Mid channel plots are shown as second trace on Low channel plot file referenced above.

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	891.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1783	-38.5	-25.5

Note: High channel plots are shown as third trace on Low channel plot file referenced above.

Dual Channel Results

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High1 channel	871.5 + 876.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1748	-40.5	-27.5

Plots
CSE, Band 869-894 MHz, Dual, 10MHz-869 MHz
CSE, Band 869-894 MHz, Dual, 894 MHz-1 GHz
CSE, Band 869-894 MHz, Dual, 1-10 GHz

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High2 channel	886.5 + 891.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1778	-41.1	-28.1

Note: High Dual mode channel plots are shown as second trace on Low Dual channel plot file referenced above.

The plots referred to in the above table may be found in section 6. Band edge results can be found in section 5.4.

File Name: Zinwave Ltd.14169-1 Issue 01

LIMITS:
Part 22.917, -13 dBm
Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ± 2.8 dB up to 26.5 GHz.

5.4 Band Edge compliance

5.4.1 Test methods

Test Requirements:	47CFR part 2J Clause 2.1051 [Reference 4.1.2 of this report], 47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.7 [Reference 4.1.4 of this report] KDB 935210 D05 Clause 3.6 [Reference 4.1.6 of this report]
Limits:	47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the 50 ohm coaxial transmit / receive port. The EUT was operated in Modes 3, 5, 6 and 7 for this test, encompassing low and high channels in both single and dual channel modes.

5.4.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. A 51kHz RBW (1% of EBW), 3x VBW, auto sweep time and max hold settings using an RMS detector were used to show the EUT's spectrum at the band/block edges integrated back to the appropriate RBW and limit. AWGN modulation and 5MHz channel bandwidth was used per KDB 935210 to measure upper and lower channel frequency signals with ACP function on the analyser enabled and plotted.

The EUT was tested in Site N.

5.4.4 Test equipment

E558, H071

See Section 8 for more details

5.4.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz
High channel	891.5 MHz
Dual Low channels	871.5 + 876.5 MHz
Dual High channels	886.5 + 891.5 MHz

Test Instance (e.g. modulation or Resource block)	Band edge result SISO Port 1 (dBm)	Plot reference Port 1	SISO Port 1 (dB) Margin
AWGN Single Low Channel	-39.91	14169-1 871.5 MHz	-26.91
AWGN Single High Channel	-42.61	14169-1 891.5 MHz	-29.61

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AWGN Dual Low Channels	-40.84	14169-1 871.5 + 876.5 MHz	-27.84
AWGN Dual High Channels	-41.68	14169-1 886.5 + 891.5 MHz	-28.68

The plots referred to in the above table may be found in section 6.

LIMITS:
Part 22.917, -13 dBm

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
± 2.8 dB up to 26.5 GHz.

5.5 Field strength of spurious emissions

5.5.1 Test methods

Test Requirements:	47CFR part 2J Clause 2.1053 [Reference 4.1.2 of this report], 47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.5 [Reference 4.1.4 of this report] KDB 935210 D05 Clause 3.6 [Reference 4.1.6 of this report]
Limits:	47 CFR Part 22H Clause 22.917 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was examined in its declared normal use position. The transmit port was terminated into a 30dB Attenuator and a 50Ohm load. RX port was terminated into a 50 Ohm load. EUT was tested in Modes 3, 4, 5, 6 and 7 for this test. Both RF ports were active during tests with the same channel frequency settings for single channel and dual channel modes of operation, therefore MIMO operation is also covered under the results listed below.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached. Peak field strength from the EUT was maximised by rotating it 360 degrees. Appropriate band-pass filters were used to ensure the fundamental did not distort the results. An RMS detector was used for final measurements.

25MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna.

1GHz – 10GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas. Tests were performed in site M.

5.5.4 Test equipment

CAL07, CAL08, E007-2, E136, E268, E411, E428, E433, E624, E642, E743, E856, E904, E932, LPE364, MS812, TMS82

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	19°C
Humidity of test environment	51%
Pressure of test environment	103kPa

Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions observed within 20 dB of limit				

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Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	881.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions observed within 20 dB of limit				

Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channel	891.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions observed within 20 dB of limit				

Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Dual Low channels	871.5 + 876.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions observed within 20 dB of limit				

Setup Table

Band	869-894 MHz
Power Level	21 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Dual High channels	886.5 + 891.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions observed within 20 dB of limit				

Note: No Spurious emissions were found within 20 dB of limits.

LIMITS:
Part 22.917, -13 dBm

File Name: Zinwave Ltd.14169-1 Issue 01

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ±3.5dB.

5.6 Frequency stability

NOT APPLICABLE: EUT does not contain an oscillator and only reproduces what is provided at its input.

5.7 Modulation Characteristics

NOT TESTED: EUT uses digital modulation techniques. Modulation schemes and information is detailed in section 2.2 of this report.

5.8 Determination of f_0

5.8.1 Test methods

Test Requirements:	KDB 935210 D05 Clause 3.3 / 4.3 [Reference 4.1.5 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.3 / 4.3 [Reference 4.1.5 of this report]
Limits:	None.

5.8.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was swept across the operational band with a CW signal to determine the frequency of highest power in the band. Test performed in mode 1.

5.8.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached. The EUT input signal was then swept across the applicable service band frequency and plots taken showing the frequency of highest power in the band (f_0).

5.8.4 Test equipment

F075, H071, E602

See Section 8 for more details

5.8.5 Test results

Temperature of test environment	18-22°C
Humidity of test environment	40-50%
Pressure of test environment	102kPa

Band	869 - 894 MHz
Power Level	21 dBm
Channel Spacing	N/A
Mod Scheme	CW

Band (MHz)	f_0 determined (MHz)
869 – 894 MHz	893.7075

Note: Measurement was performed over the service band frequency range only.

Results are also presented graphically in section 6.

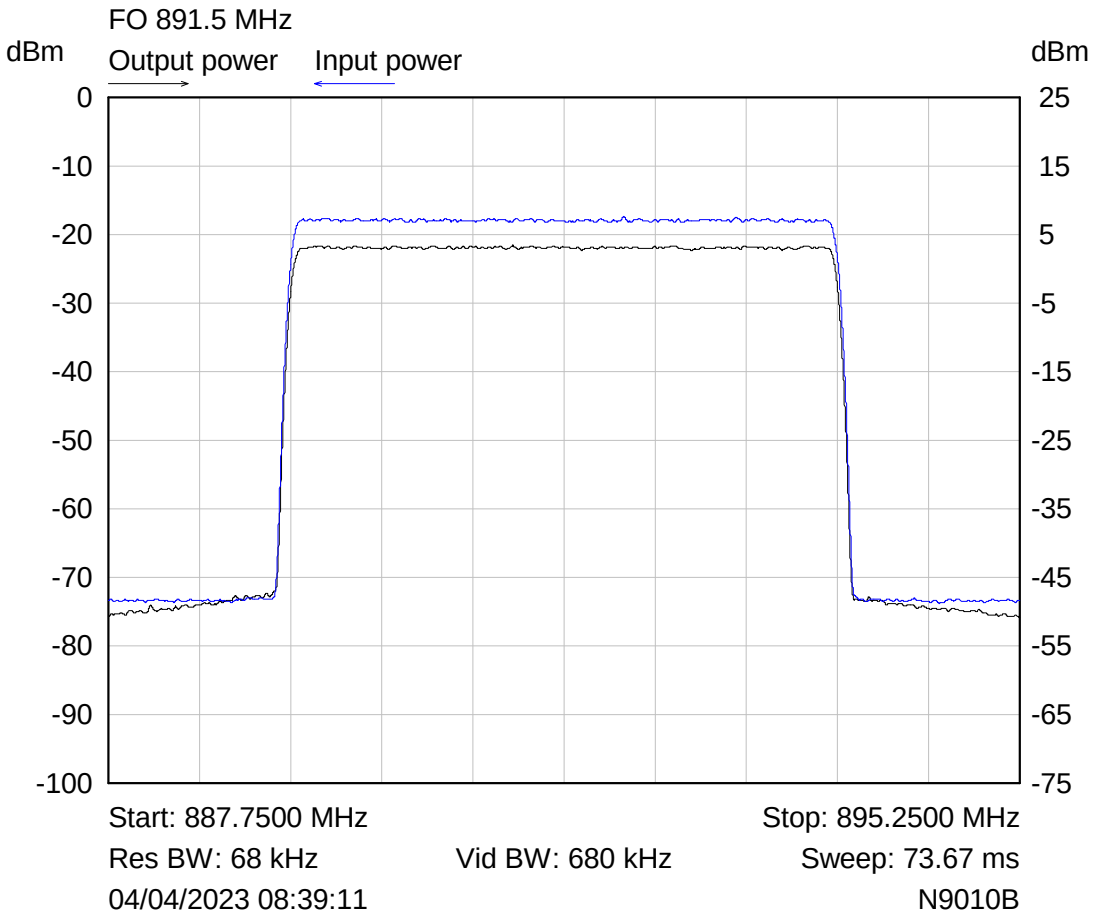
LIMITS:
None.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1 dB

6 Plots/Graphical results

6.1 RF Power Output (ERP)

RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, Channel 891.5 MHz (channel centre near to determined FO)



Input power

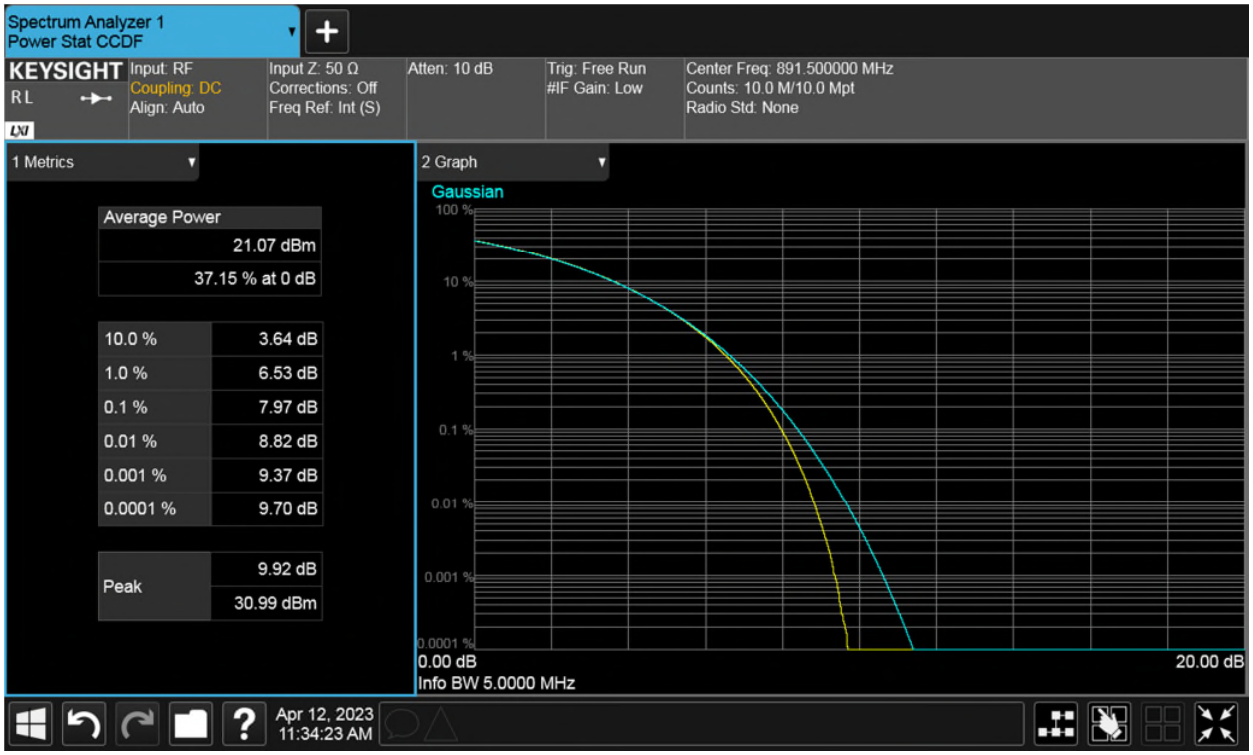
Measurement Parameter	Value
Total channel power	-0.03 dBm
Power Spectral Density	-7.02 dBm/MHz

Output power

Measurement Parameter	Value
Total channel power	20.98 dBm
Power Spectral Density	13.99 dBm/MHz

Input versus Output power Plot (channel closest to determined fo)

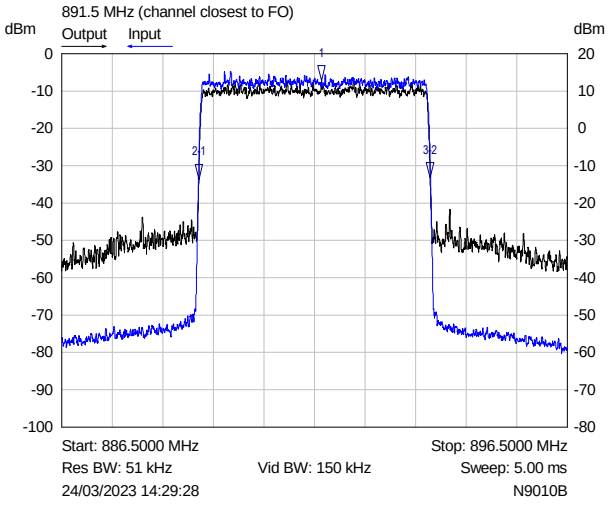
File Name: Zinwave Ltd.14169-1 Issue 01



PAPR Plot (channel closest to determined fo)

6.2 Occupied bandwidth / Input vs Output

RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, Channel 891.5 MHz (FO)



Mkr	Trace	X-Axis	Value	Notes
1	Output	891.6370 MHz	12.78 dBm	
2-1	Output	-2.4285 MHz	-26.37 dB	
3-2	Output	4.5809 MHz	0.45 dB	

Output

Measurement Parameter	Value
Occupied Bandwidth	4.4228 MHz

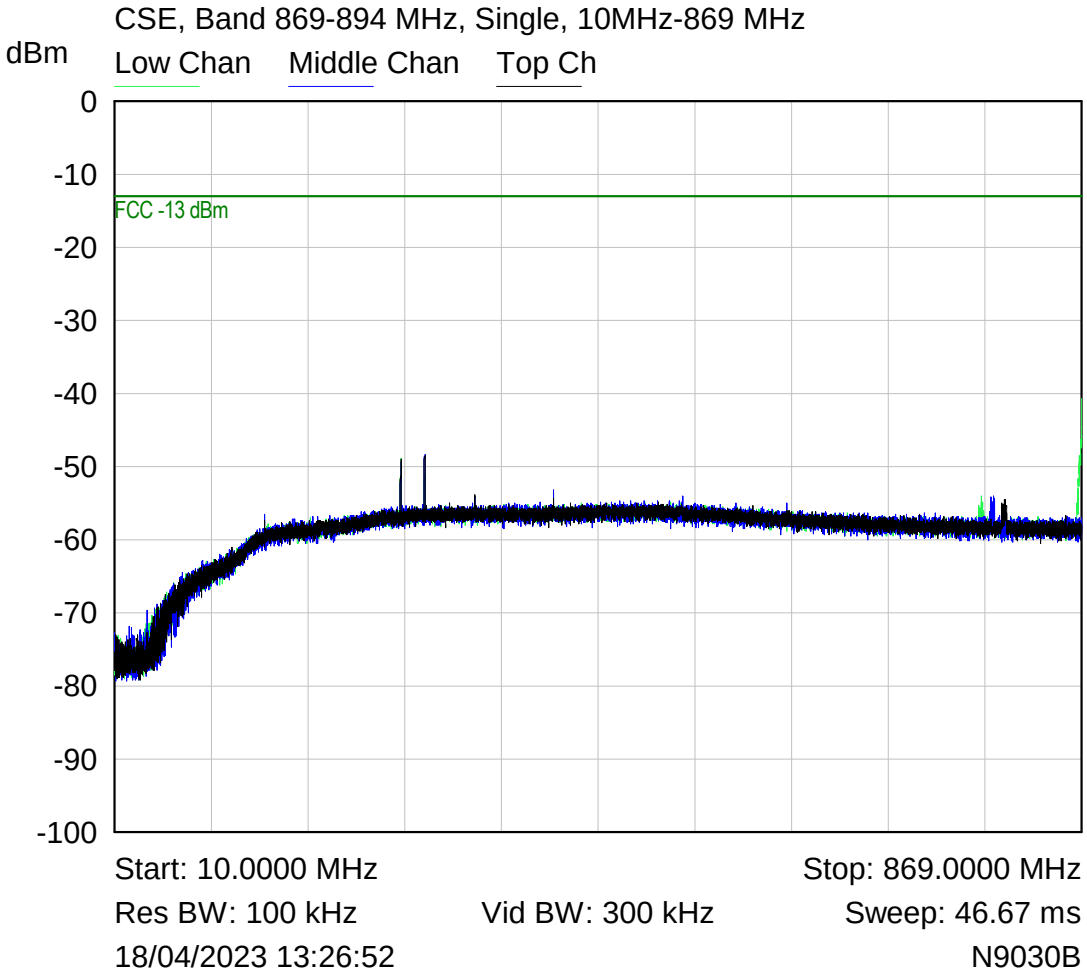
Input

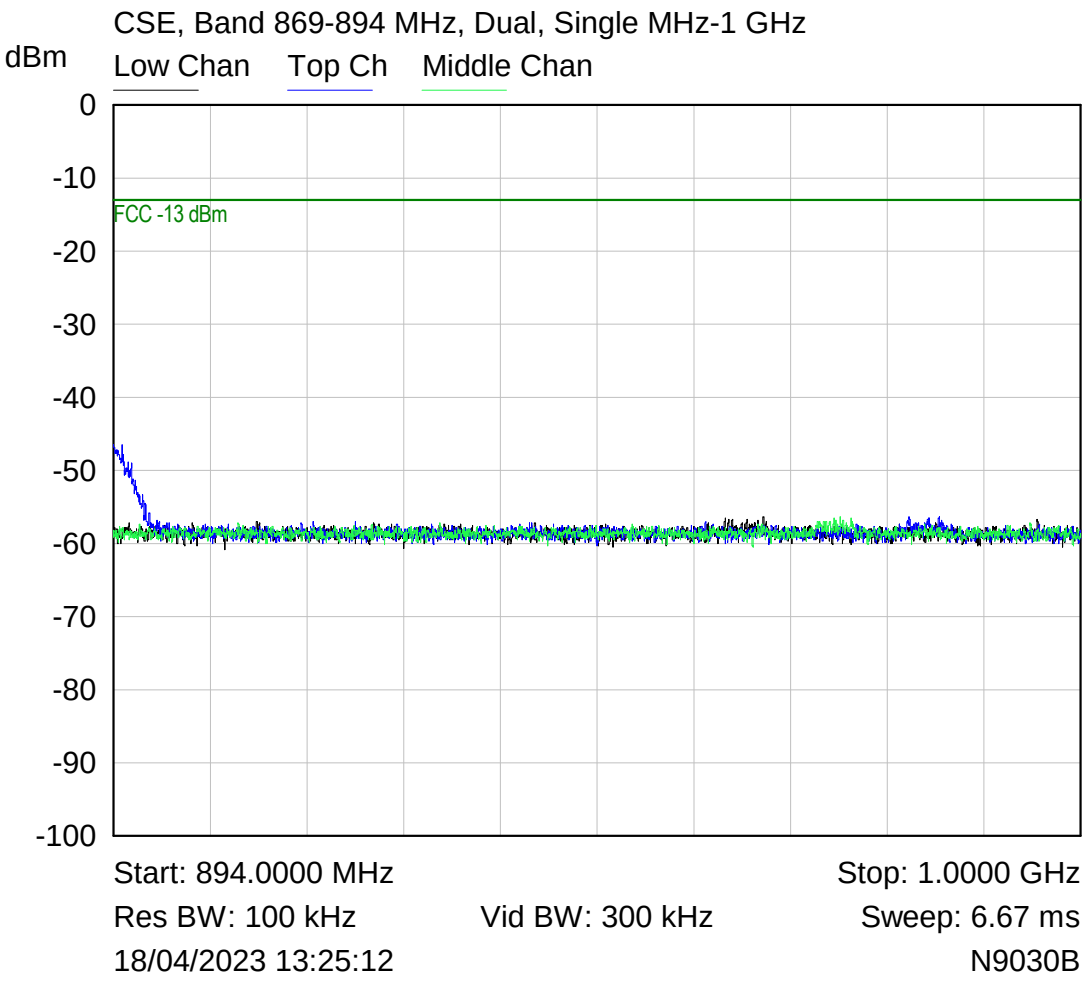
Measurement Parameter	Value
Occupied Bandwidth	4.4241 MHz

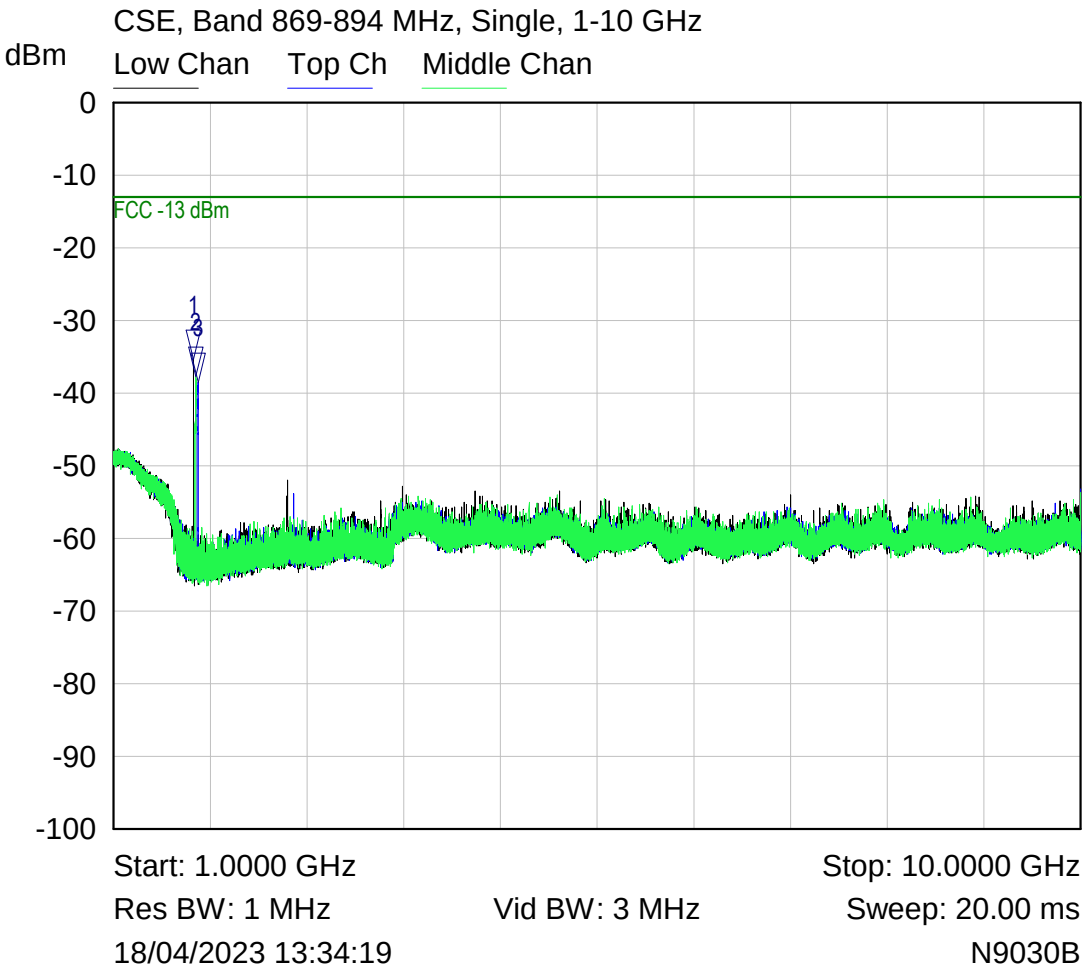
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts (channel closest to determined fo)

6.3 Spurious emissions at antenna terminals

RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, single channel mode

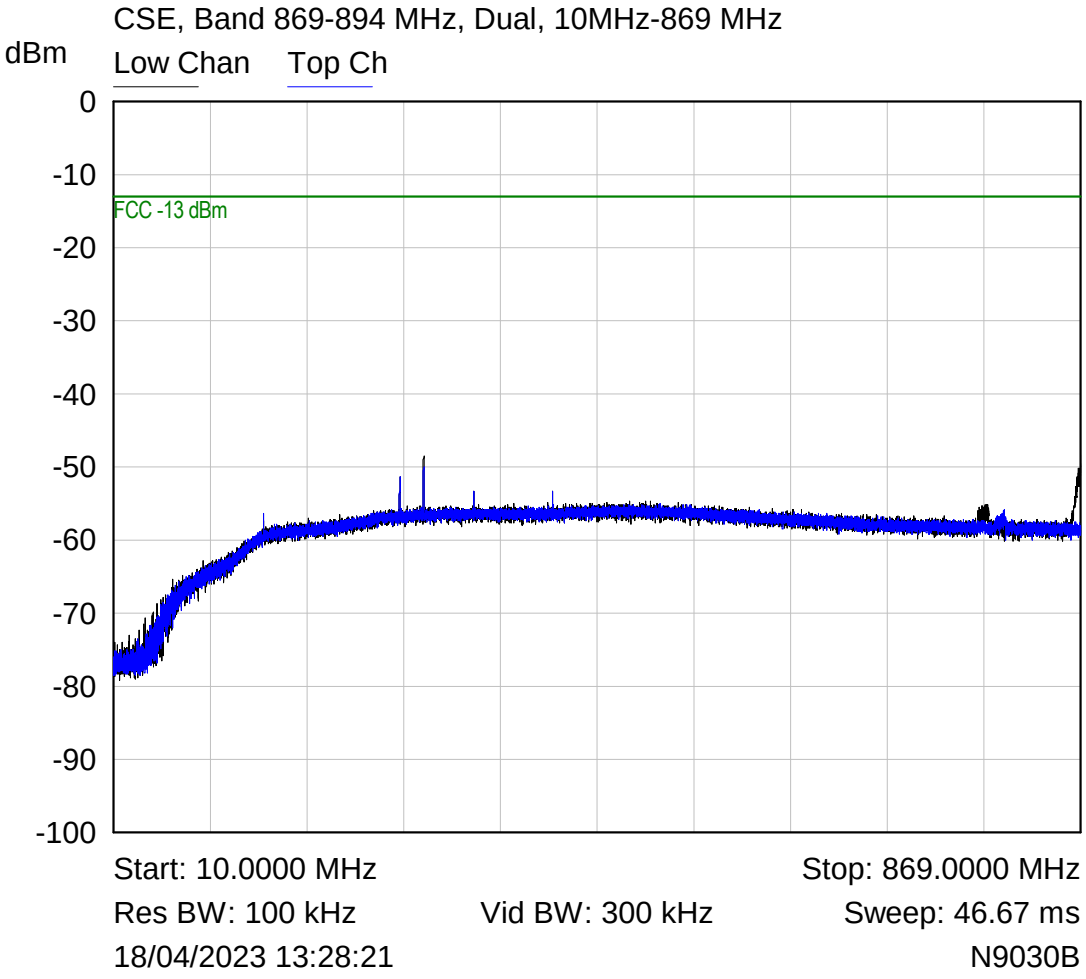


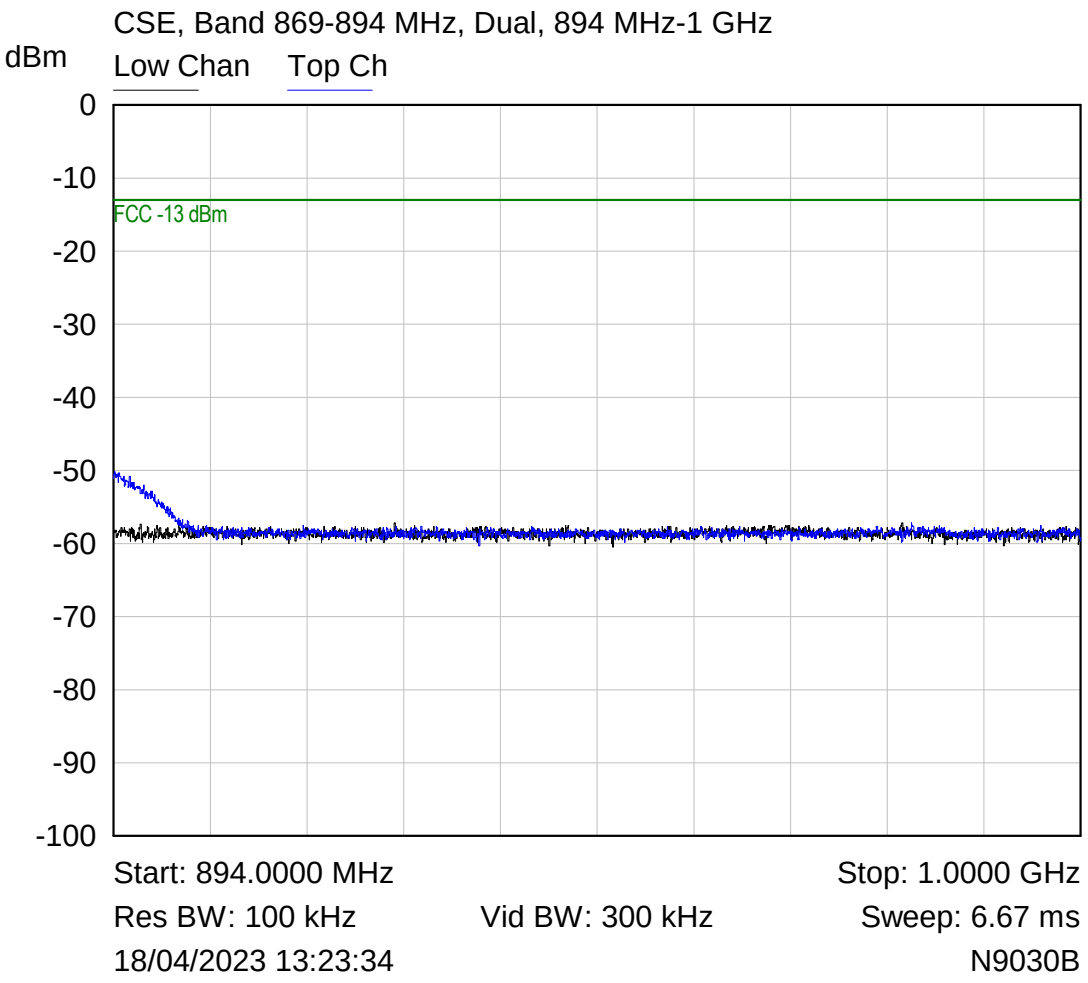

CSE, Band 869-894 MHz, Dual, Single MHz-1 GHz
dBm
Low Chan
Top Ch
Middle Chan
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
FCC -13 dBm
Start: 894.0000 MHz
Stop: 1.0000 GHz
Res BW: 100 kHz
Vid BW: 300 kHz
Sweep: 6.67 ms
18/04/2023 13:25:12
N9030B

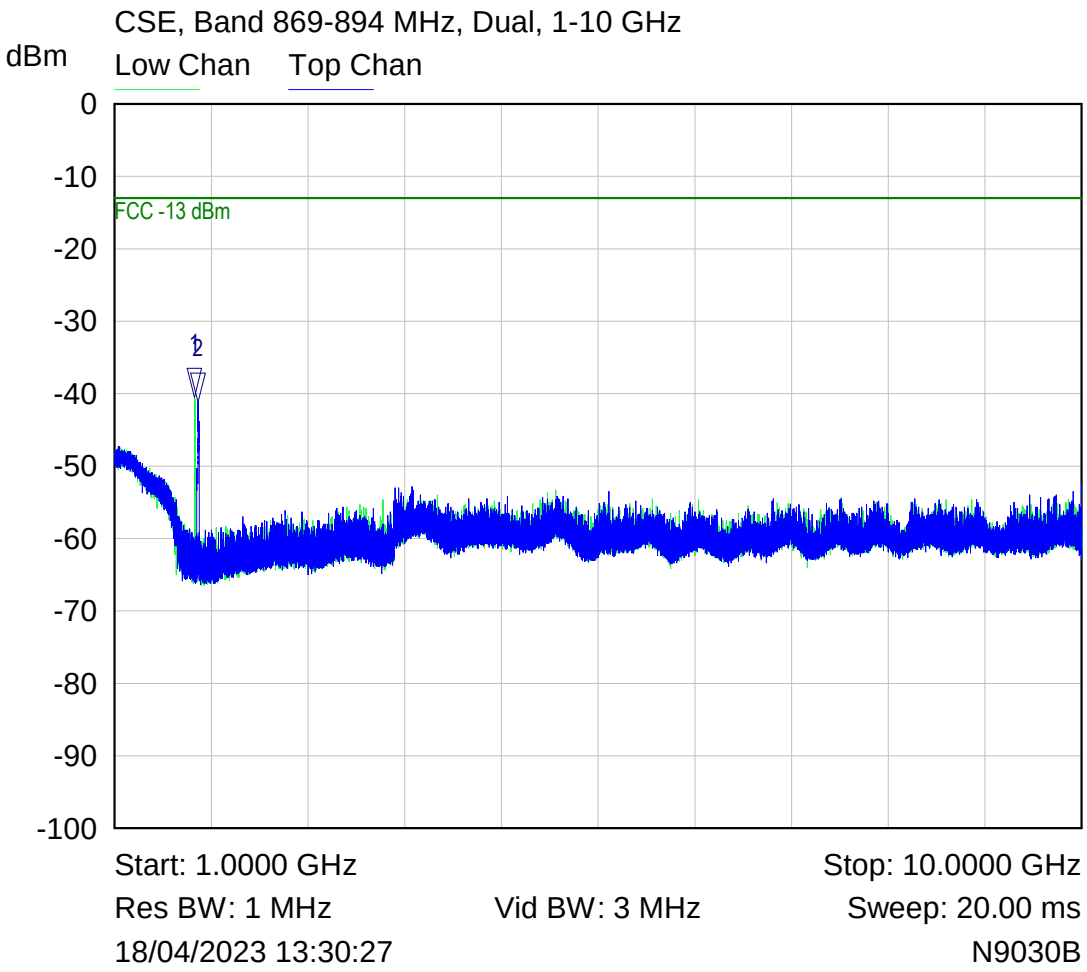


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Low Chan	1.7425 GHz	-35.32 dBm	
2 ▽	Middle Chan	1.7630 GHz	-37.70 dBm	
3 ▽	Top Ch	1.7830 GHz	-38.46 dBm	

RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, Dual channel mode



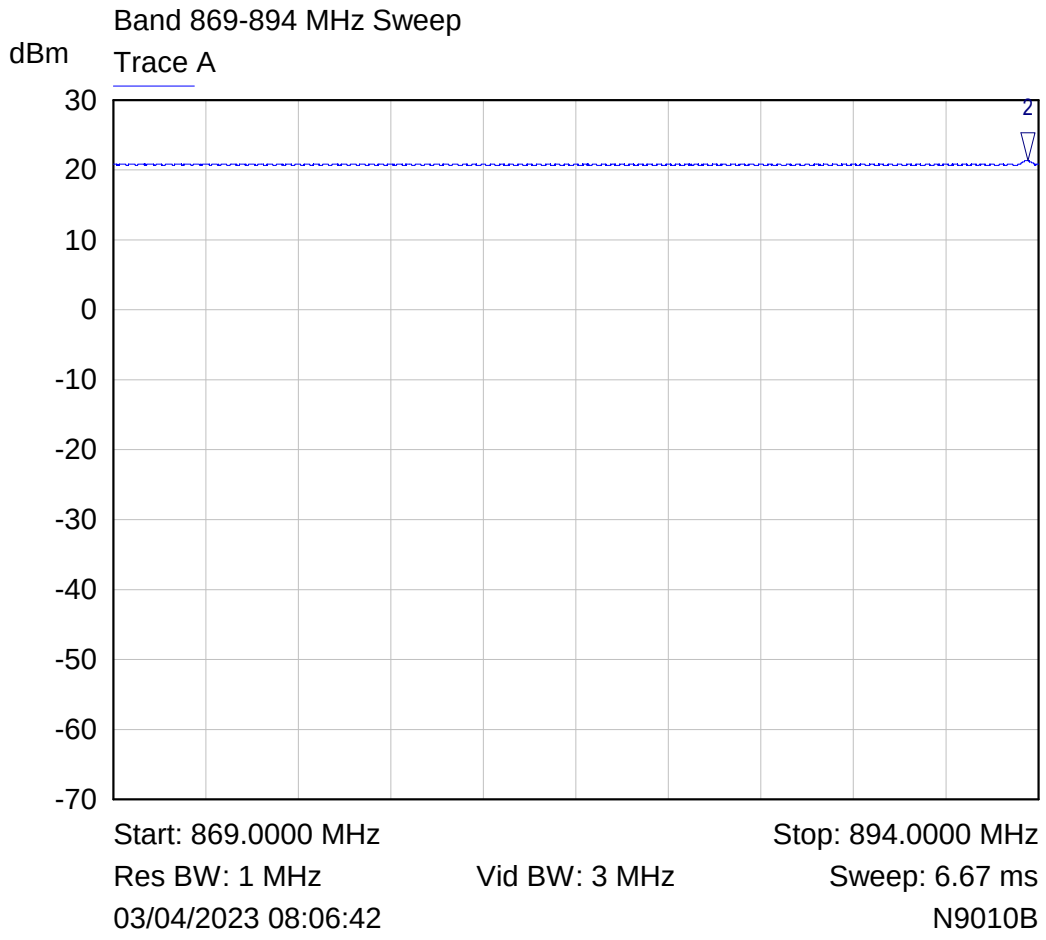

CSE, Band 869-894 MHz, Dual, 894 MHz-1 GHz
dBm
Low Chan
Top Ch
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
FCC -13 dBm
Start: 894.0000 MHz
Stop: 1.0000 GHz
Res BW: 100 kHz
Vid BW: 300 kHz
Sweep: 6.67 ms
18/04/2023 13:23:34
N9030B



Mkr	Trace	X-Axis	Value	Notes
1	Low Chan	1.7480 GHz	-40.51 dBm	
2	Top Chan	1.7778 GHz	-41.10 dBm	

6.4 Determination of fo

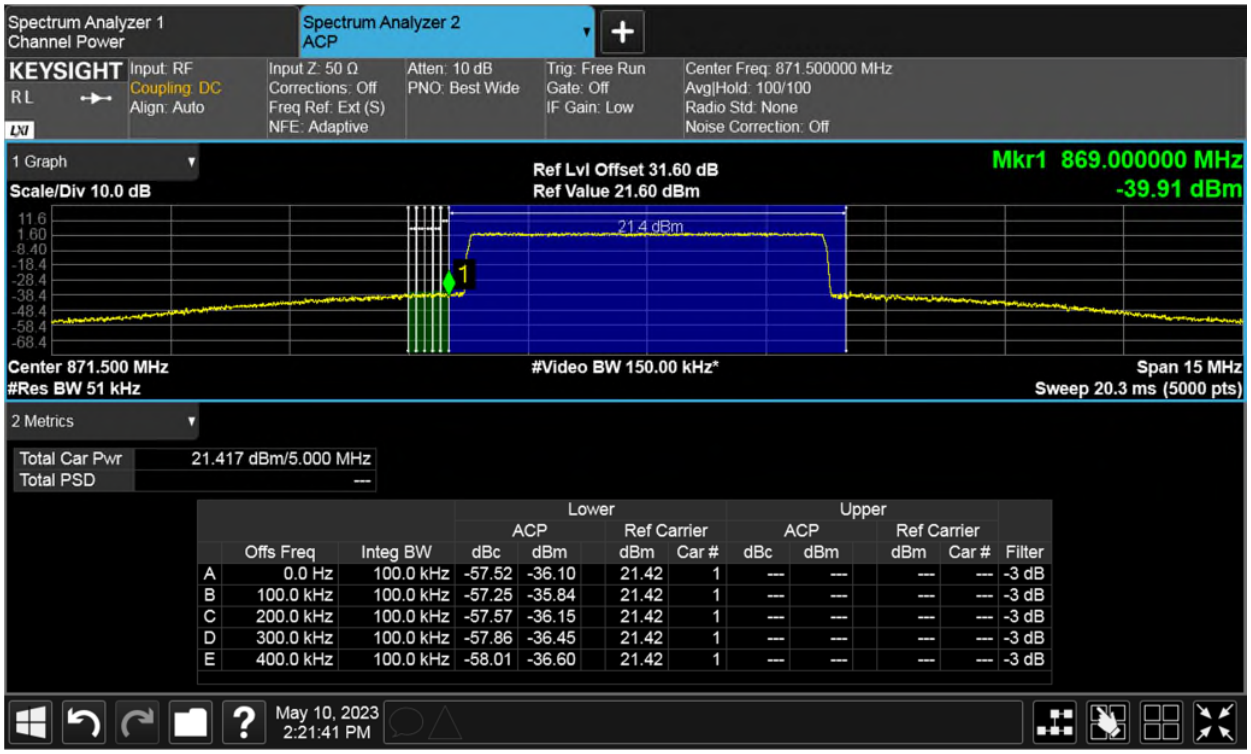
RF Parameters: Band 869-894 MHz, Power 21 dBm, CW frequency sweep, determination of fo



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	893.7075 MHz	21.29 dBm	

6.5 Band edges

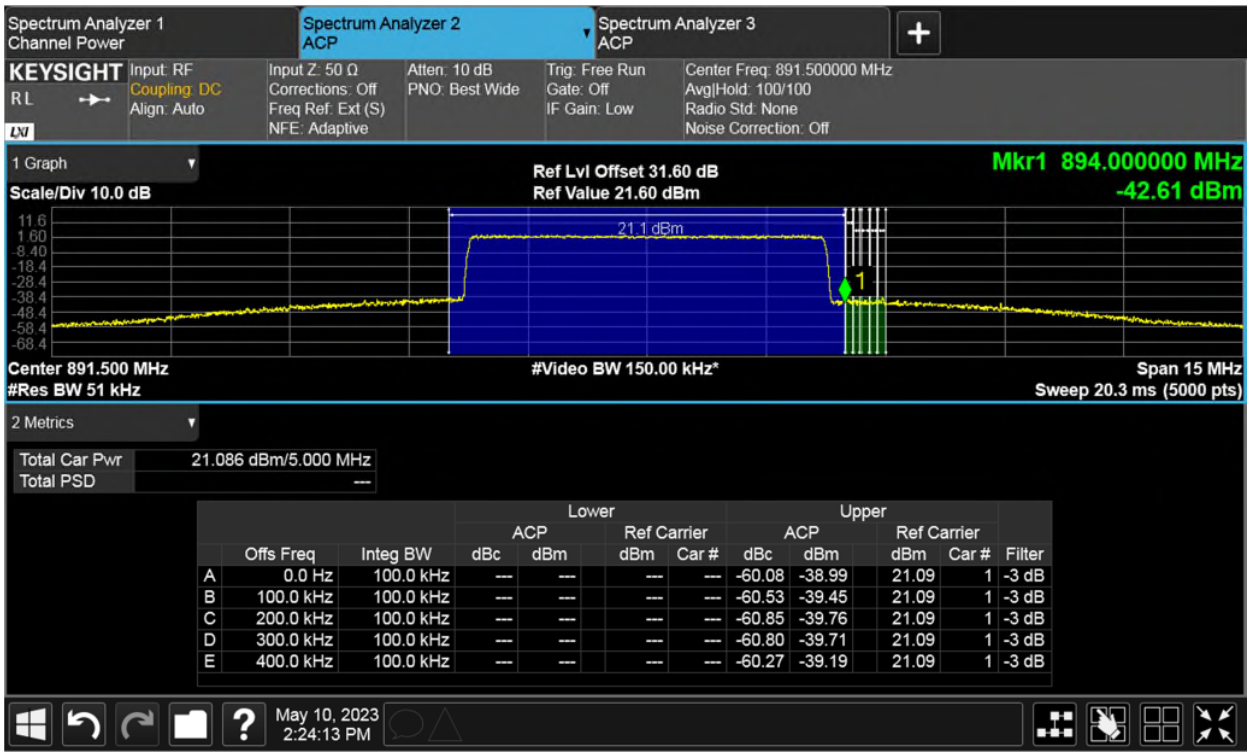
RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, single Low channel mode



			Lower				Upper				
			ACP		Ref Carrier		ACP		Ref Carrier		
	Offs Freq	Integ BW	dBc	dBm	dBm	Car #	dBc	dBm	dBm	Car #	Filter
A	0.0 Hz	100.0 kHz	-57.52	-36.10	21.42	1	---	---	---	---	-3 dB
B	100.0 kHz	100.0 kHz	-57.25	-35.84	21.42	1	---	---	---	---	-3 dB
C	200.0 kHz	100.0 kHz	-57.57	-36.15	21.42	1	---	---	---	---	-3 dB
D	300.0 kHz	100.0 kHz	-57.86	-36.45	21.42	1	---	---	---	---	-3 dB
E	400.0 kHz	100.0 kHz	-58.01	-36.60	21.42	1	---	---	---	---	-3 dB

Low channel Band edge

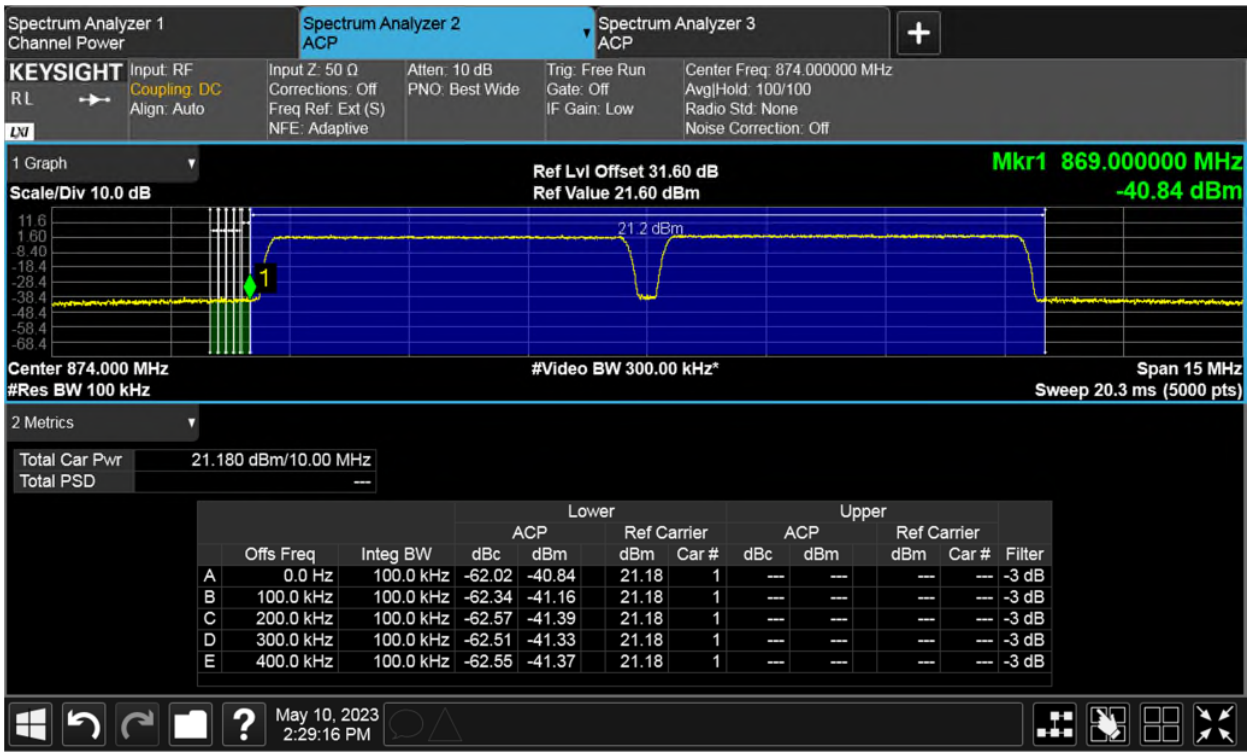
RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, single High channel mode



			Lower				Upper				
			ACP		Ref Carrier		ACP		Ref Carrier		
	Offs Freq	Integ BW	dBc	dBm	dBm	Car #	dBc	dBm	dBm	Car #	Filter
A	0.0 Hz	100.0 kHz	---	---	---	---	-60.08	-38.99	21.09	1	-3 dB
B	100.0 kHz	100.0 kHz	---	---	---	---	-60.53	-39.45	21.09	1	-3 dB
C	200.0 kHz	100.0 kHz	---	---	---	---	-60.85	-39.76	21.09	1	-3 dB
D	300.0 kHz	100.0 kHz	---	---	---	---	-60.80	-39.71	21.09	1	-3 dB
E	400.0 kHz	100.0 kHz	---	---	---	---	-60.27	-39.19	21.09	1	-3 dB

High channel Band edge

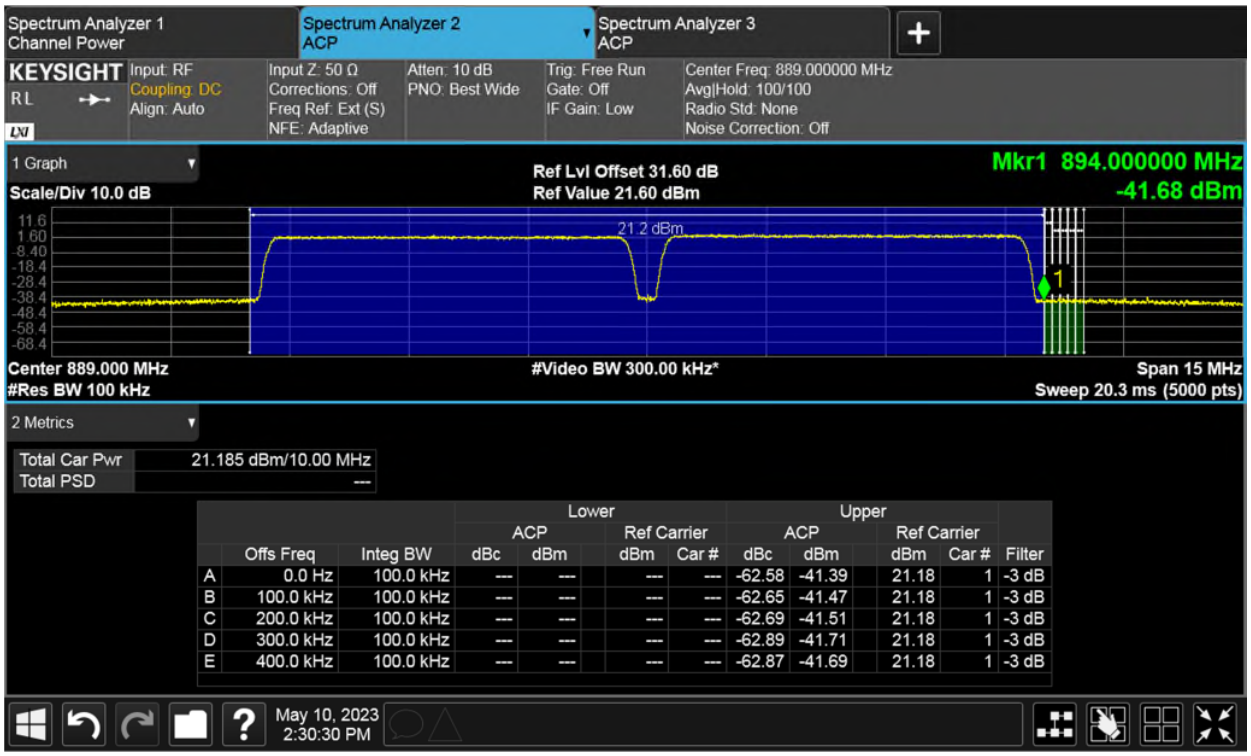
RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, single Dual Low channel mode



			Lower				Upper				
			ACP		Ref Carrier		ACP		Ref Carrier		
	Offs Freq	Integ BW	dBc	dBm	dBm	Car #	dBc	dBm	dBm	Car #	Filter
A	0.0 Hz	100.0 kHz	-62.02	-40.84	21.18	1	---	---	---	---	-3 dB
B	100.0 kHz	100.0 kHz	-62.34	-41.16	21.18	1	---	---	---	---	-3 dB
C	200.0 kHz	100.0 kHz	-62.57	-41.39	21.18	1	---	---	---	---	-3 dB
D	300.0 kHz	100.0 kHz	-62.51	-41.33	21.18	1	---	---	---	---	-3 dB
E	400.0 kHz	100.0 kHz	-62.55	-41.37	21.18	1	---	---	---	---	-3 dB

Dual Low channel Band edge

RF Parameters: Band 869-894 MHz, Power 21 dBm, Channel Spacing 5 MHz, Modulation AWGN, single Dual High channel mode

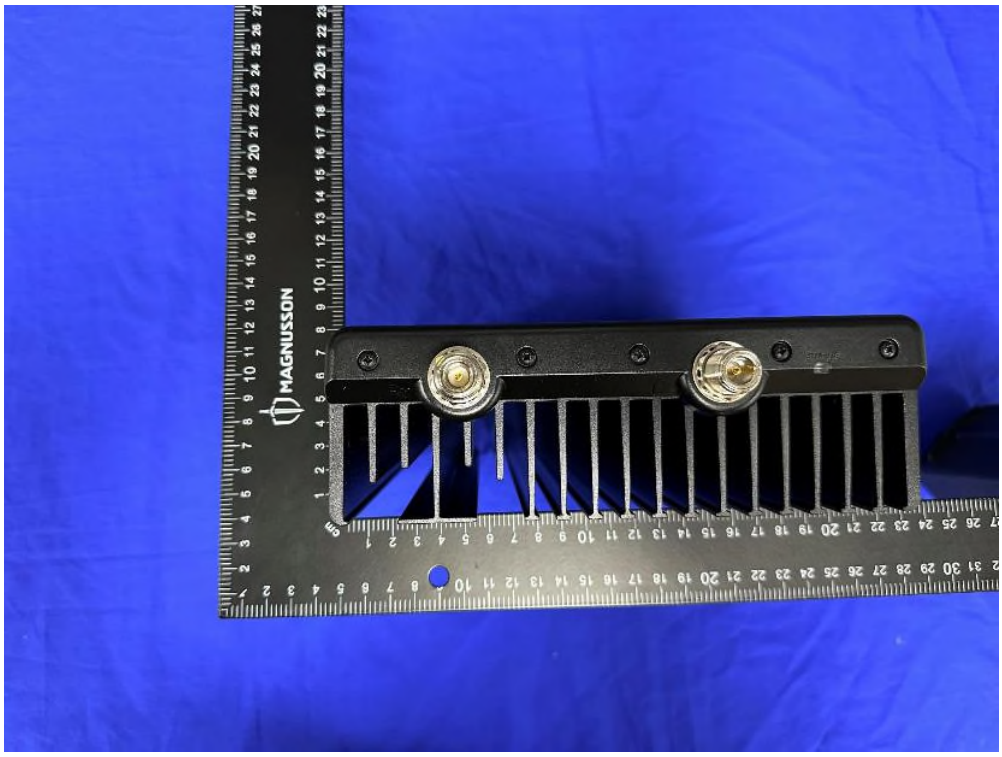


			Lower				Upper				
			ACP		Ref Carrier		ACP		Ref Carrier		
	Offs Freq	Integ BW	dBc	dBm	dBm	Car #	dBc	dBm	dBm	Car #	Filter
A	0.0 Hz	100.0 kHz	---	---	---	---	-62.58	-41.39	21.18	1	-3 dB
B	100.0 kHz	100.0 kHz	---	---	---	---	-62.65	-41.47	21.18	1	-3 dB
C	200.0 kHz	100.0 kHz	---	---	---	---	-62.69	-41.51	21.18	1	-3 dB
D	300.0 kHz	100.0 kHz	---	---	---	---	-62.89	-41.71	21.18	1	-3 dB
E	400.0 kHz	100.0 kHz	---	---	---	---	-62.87	-41.69	21.18	1	-3 dB

Dual High channel Band edge

7 Photographs

7.1 EUT Front View



File Name: Zinwave Ltd.14169-1 Issue 01

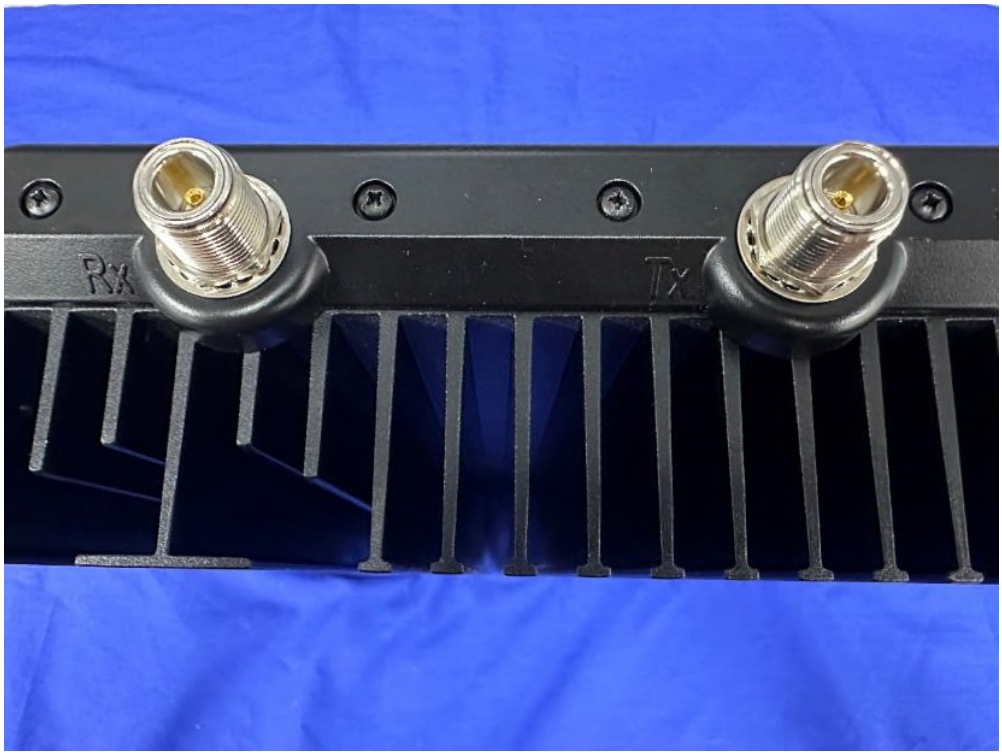
7.2 EUT Reverse Angle

File Name: Zinwave Ltd.14169-1 Issue 01

7.3 EUT Left side View

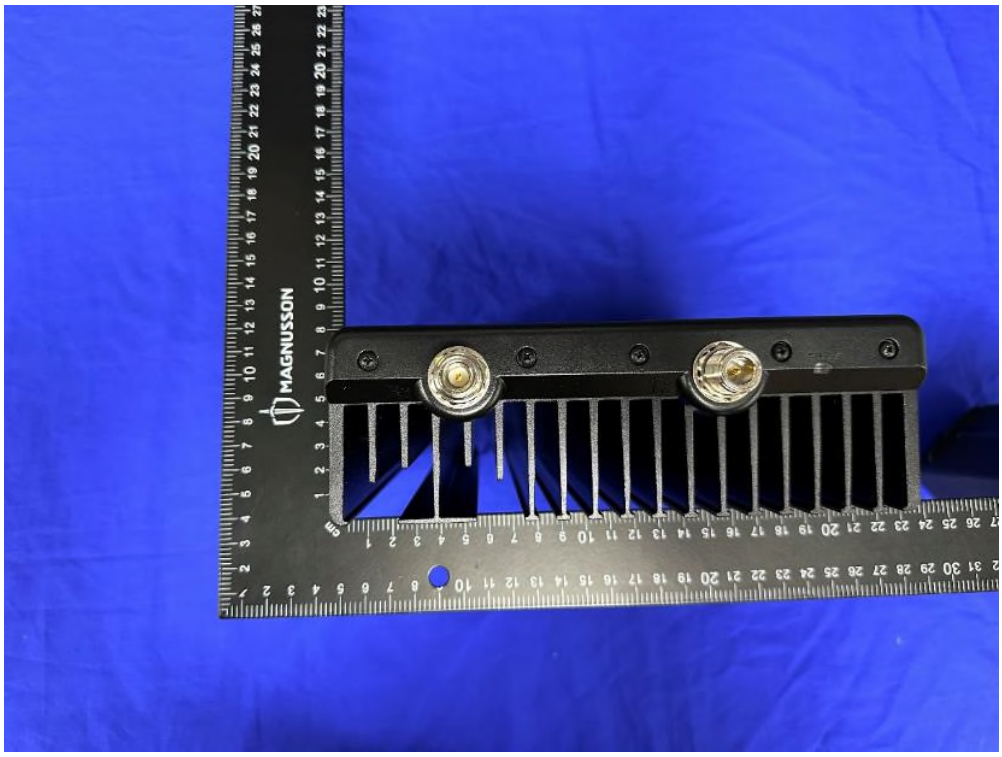
7.4 EUT Right side View

7.5 EUT Antenna Ports



File Name: Zinwave Ltd.14169-1 Issue 01

7.6 EUT Display & Controls



7.7 EUT Internal photos

EUT not disassembled for internal photographs due to complexity of unit.

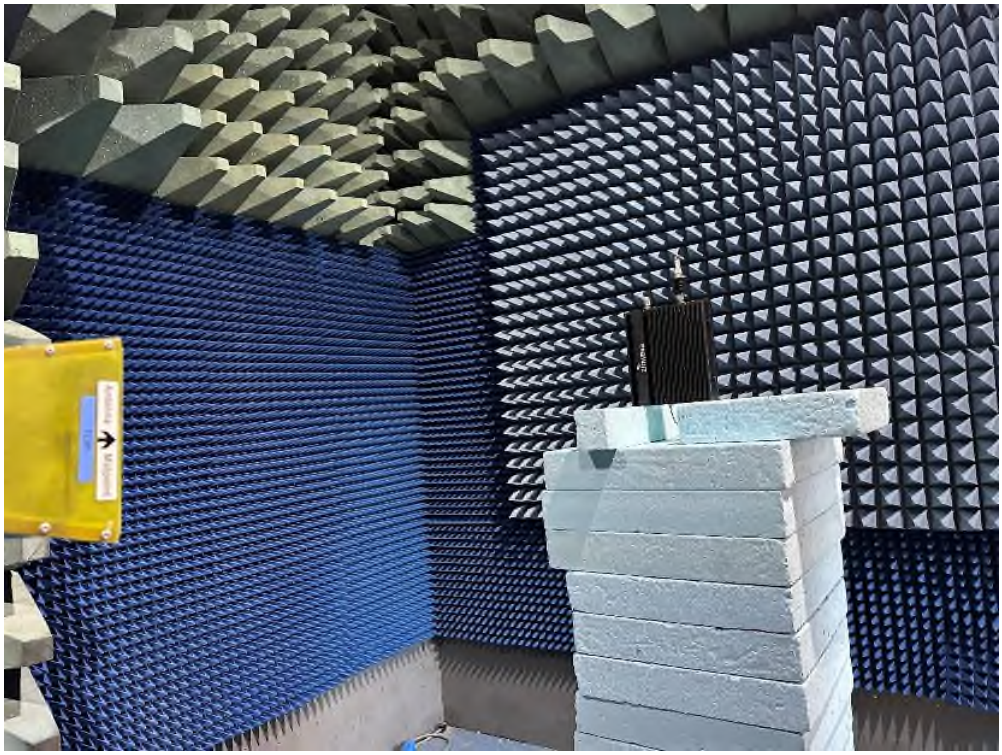
7.8 EUT ID Label

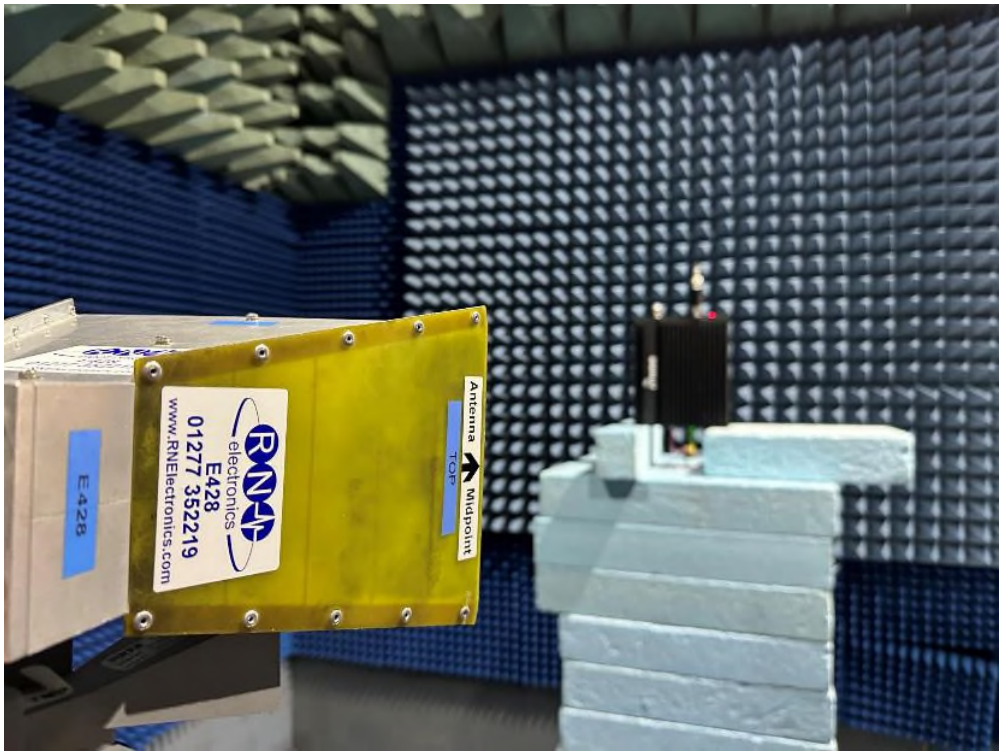

48V DC 0.9A
OUT IN
Alarm

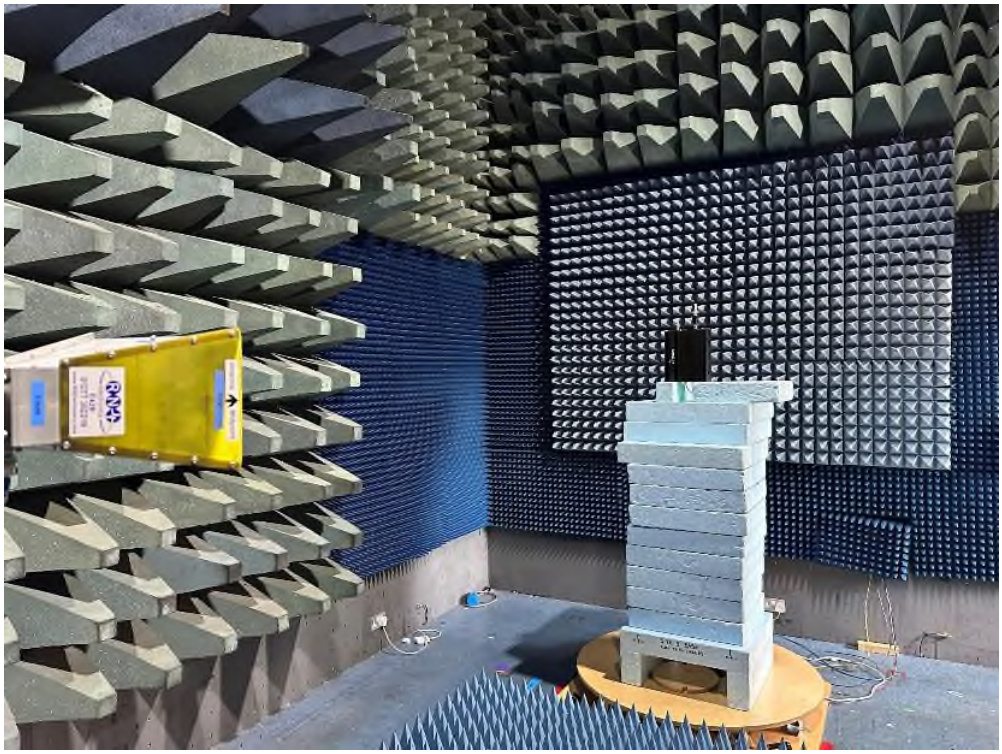

48V DC 0.9A
Dec 2022
8101100001990

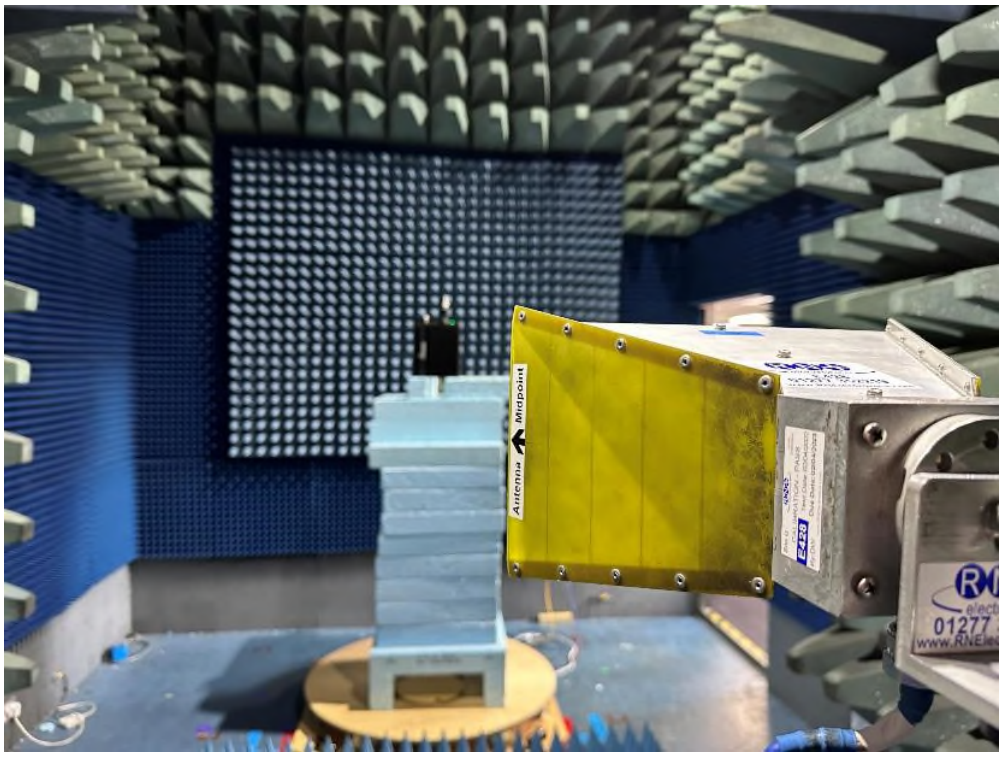
7.9 EUT Chassis

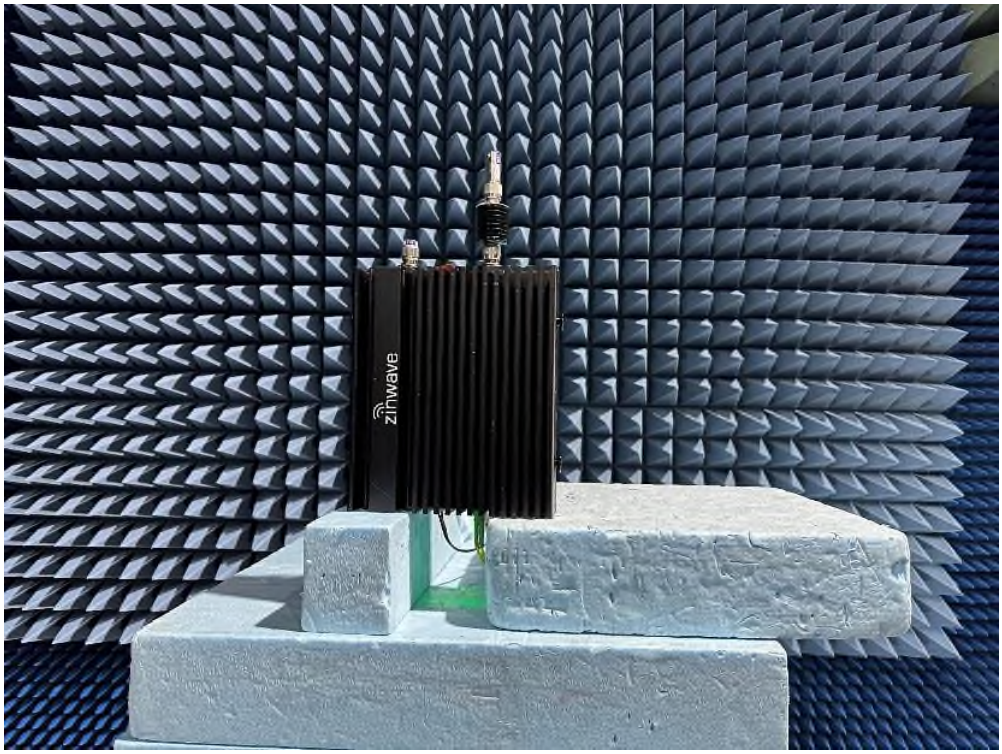
7.9 Spurious emission Test Set-up photos

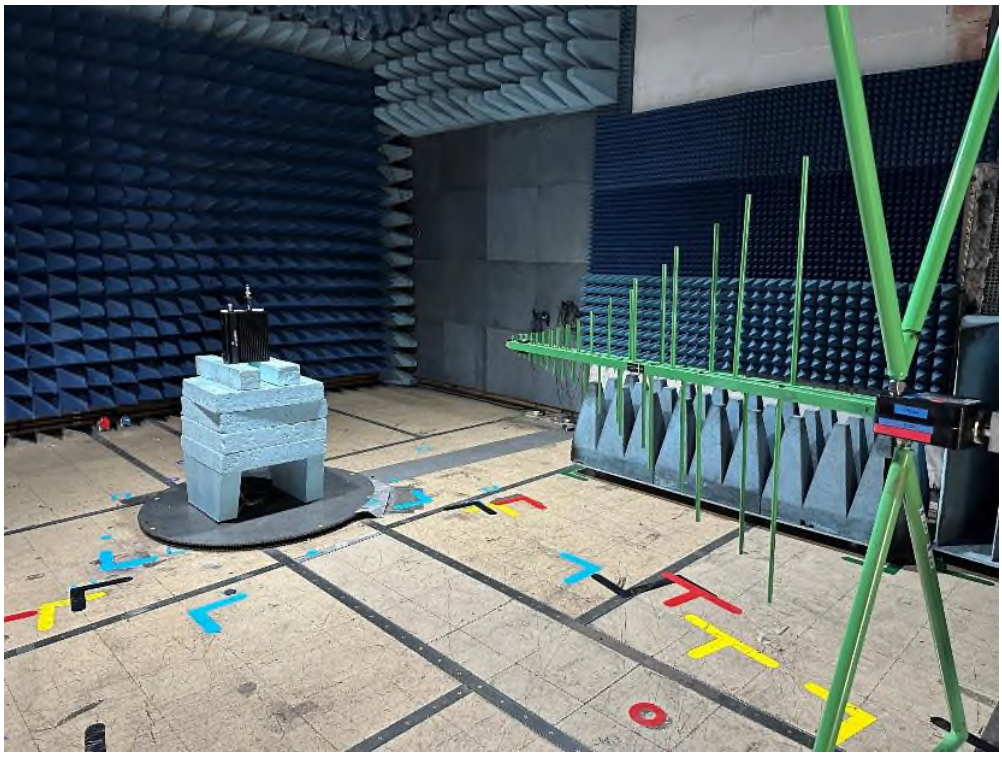


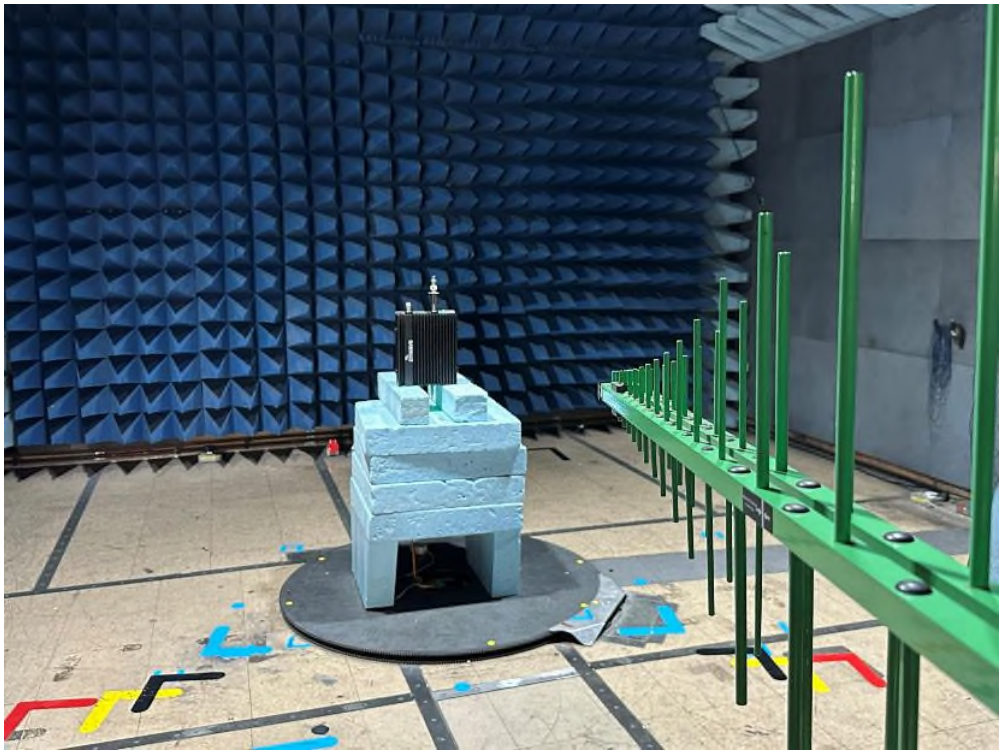


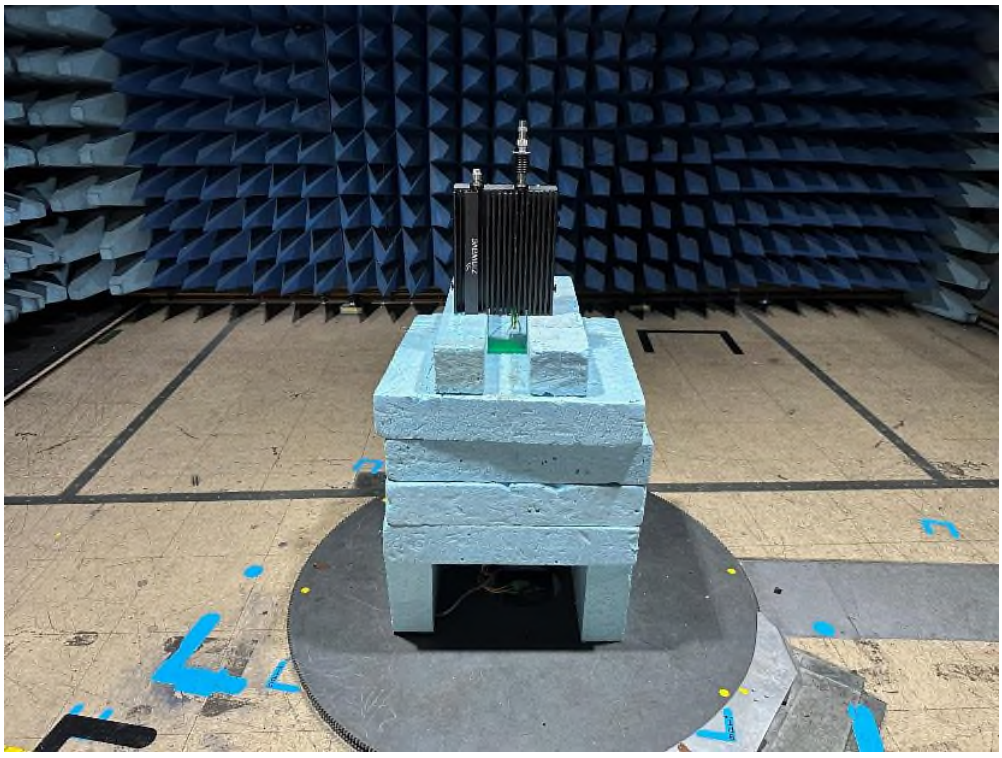



Antenna Midpoint

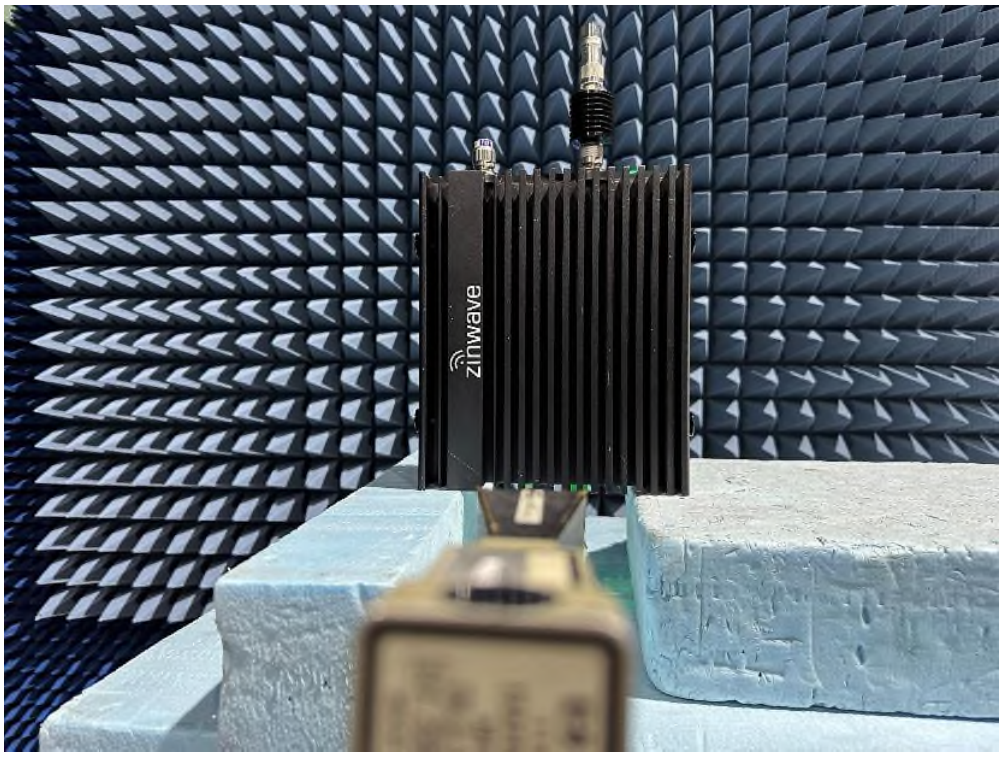

zinwave

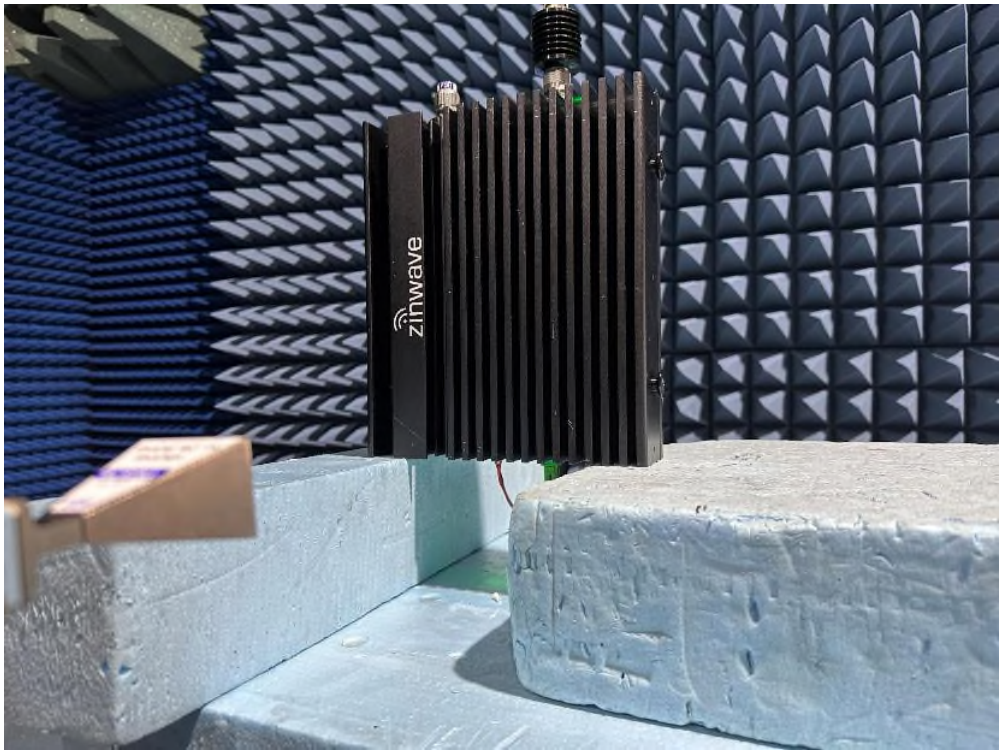


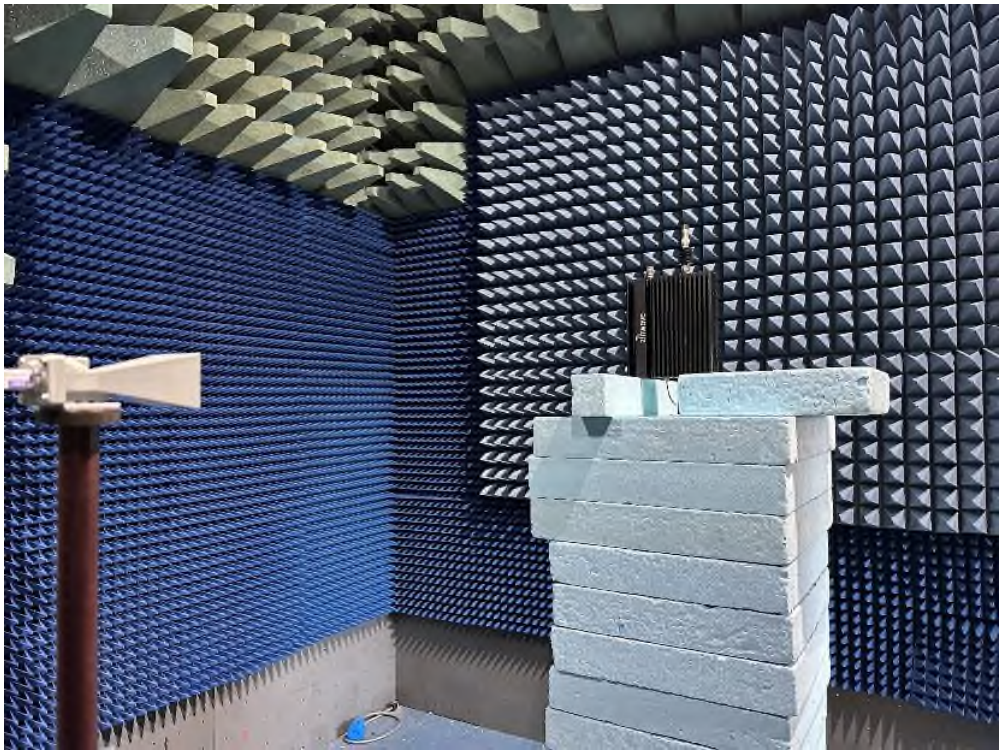


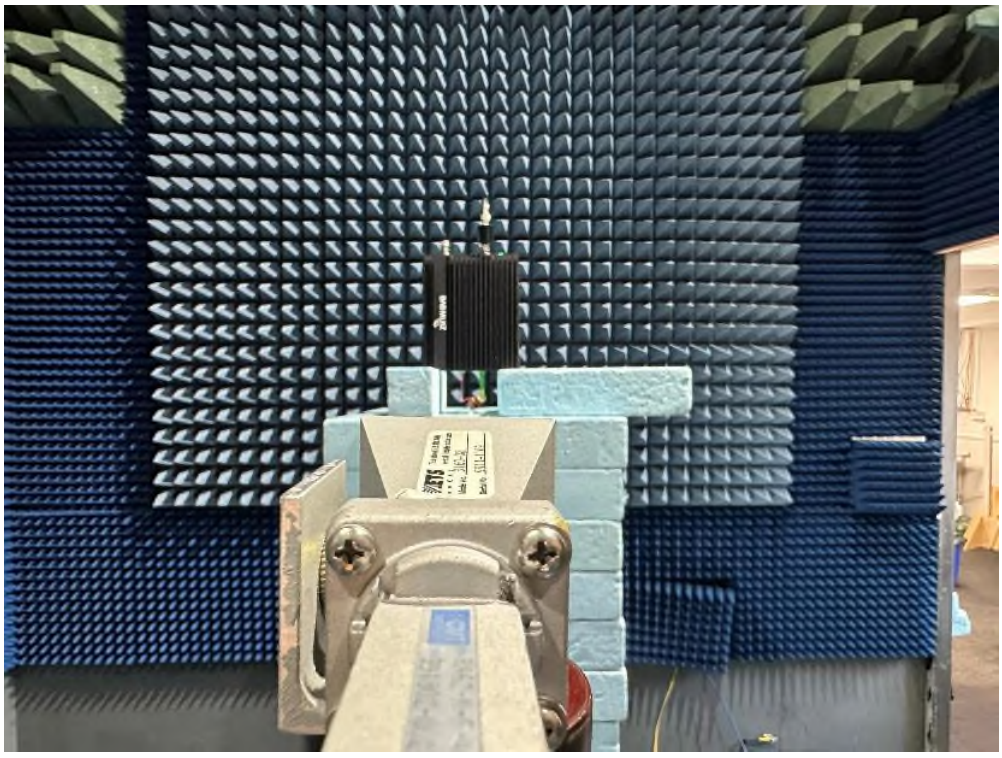



zinwave


zinwave







7.10 Radiated emission diagrams

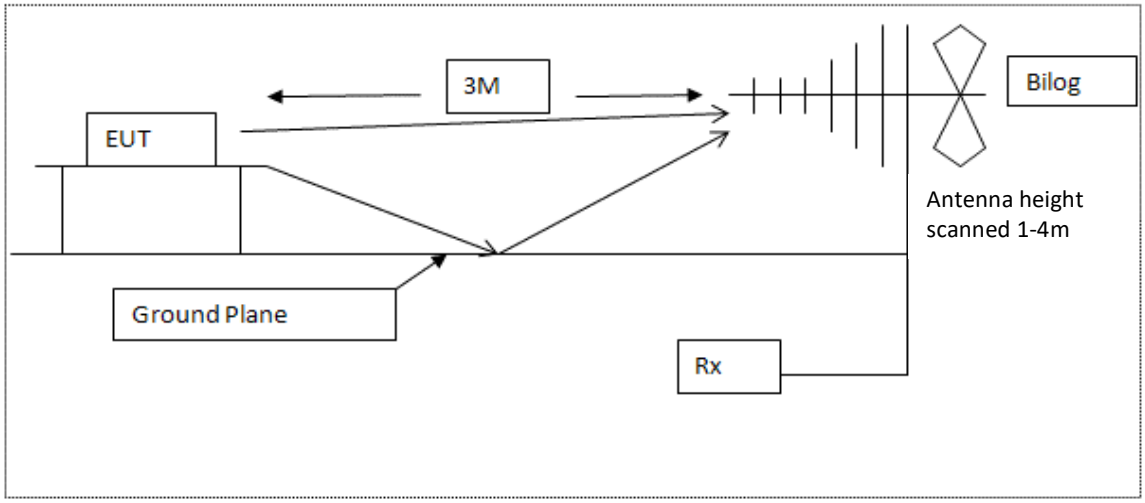


Diagram of the radiated emissions test setup 30 - 1000 MHz

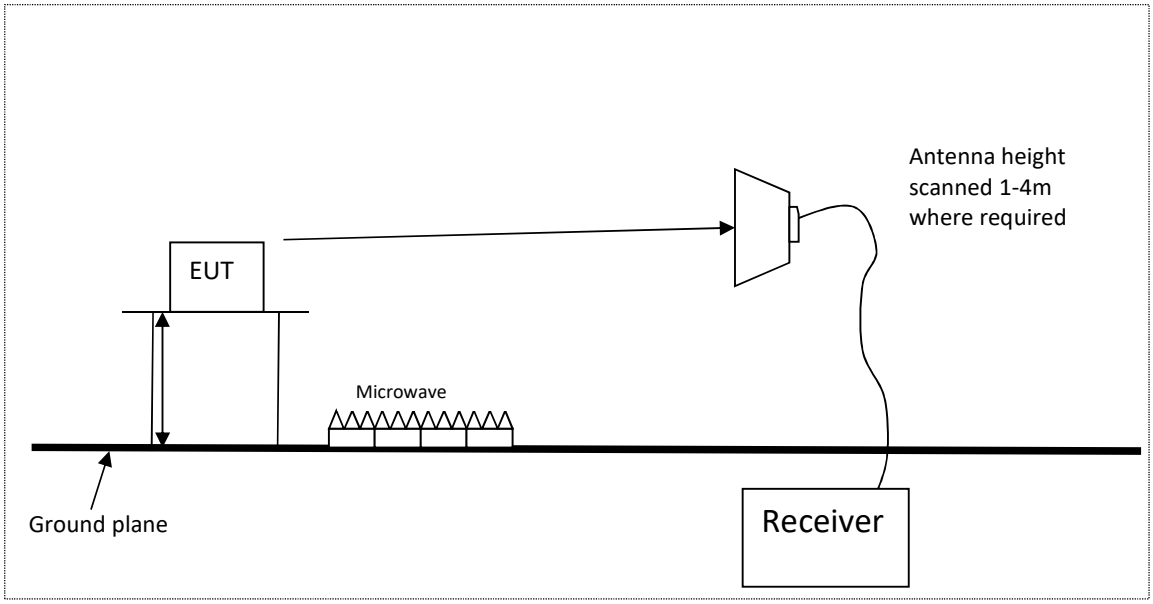


Diagram of the radiated emissions test setup above 1GHz

8 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
CAL07	MWX221	Cable N Type to SMA Blue 2m	Junflon	16-Dec-2022	6 months
CAL08	MWX221	Cable N Type to SMA Blue 2m	Junflon	12-Aug-2022	12 months
E007-2	VHA9103	Antenna Bi-con	Schwarzbeck	23-Apr-2021	36 months
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	#02-Apr-2023	12 months
E268	BHA 9118	Horn Antenna 1 - 18 GHz	Schaffner	#02-Apr-2023	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Jul-2022	12 months
E428	HF906	Horn Antenna 1 - 18 GHz	Rohde & Schwarz	#02-Apr-2023	12 months
E433	MG3693A	Signal Generator 2 GHz - 30 GHz	Anritsu	03-Oct-2022	12 months
E558	18N20W-30dB	Attenuator 30dB 20W	Inmet	17-Mar-2023	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2022	24 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Dec-2022	24 months
E701	MG3710A	Signal Generator 0.1 - 6000 MHz	Anritsu	09-Feb-2023	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	15-Mar-2023	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	06-Dec-2022	12 months
E904	5086-7805	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	#03-Ma7-2023	12 months
E932	N5181A	Signal Generator 100kHz to 6GHz	Agilent Technologies	08-Jun-2022	12 months
F030	X6L120-1250-0017-0001-00	Filter Low Pass 1250MHz	K&L Microwave Inc	Checked prior to use	
F031	X6L120-1250-0017-0001-00	Filter Low Pass 1250MHz	K&L Microwave Inc	Checked prior to use	
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	12-Dec-2022	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	16-Dec-2022	12 months

Equipment was within calibration dates for tests and has been re-calibrated since/during date of tests.

9 Auxiliary and peripheral equipment

9 .1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	308-0001	Primary Hub	Zinwave Ltd	00-17-68-00-31-E2
2	4977761	Secondary Hub	Zinwave Ltd	620200002612 Artesyn

9 .2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
E558	18N20W-30dB	Attenuator 30dB 20W	Inmet	-
E701	MG3710A	Signal Generator 0.1 - 6000 MHz	Anritsu	6201305571
F390	908A	Termination N Type m 4GHz	Hewlett Packard	-
F391	R404131000	Termination N type 4GHz	Radiall	-
I258	HP 250 G6	Laptop HP 250 G6	Hewlett Packard	CND82494B7

10 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

10.1 Modifications before test

Software was upgraded from 0.01(b5b8d31) to 0.01(4b3aq2e) in the primary hub before test to so its internal calibration could be performed correctly. The Software was upgraded again from 0.01(4b3aq2e) to 0.01(e15853b) in the primary hub during test to resolve an emissions problem at 91 MHz away from the fundamental which was cause by fibre communication. Although the Primary hub is not under test the EUT can't operate without it and it contributes to test results.

10.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

11 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 293246, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-2, VCCI Registration No. 4065

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246, ISED Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK0015

12 Abbreviations and units

%	Percent
λ	Wavelength
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ACK	ACKnowledgement
ACP	Adjacent Channel Power
AFA	Adaptive Frequency Agility
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ANSI	American National Standards Institute
ATPC	Automatic Transmit Power Control
AVG	Average
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BT	BlueTooth
BLE	BlueTooth Low Energy
BW	Bandwidth
ºC	Degrees Celsius
C/I	Carrier / Interferer
CAC	Channel Availability Check
CCA	Clear Channel Assessment
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
CISPR	Comité International Spécial des Perturbations Radioélectriques
cm	centimetre
COFDM	Coherent OFDM
COT	Channel Occupancy Time
CS	Channel Spacing
CW	Continuous Wave
DAA	Detect And Avoid
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBµV/m	deciBels relative to 1µV/m
dBc	deciBels relative to Carrier
dBd	deciBels relative to dipole gain
dBi	deciBels relative to isotropic gain
dBm	deciBels relative to 1mW
dBr	deciBels relative to a maximum value
dBW	deciBels relative to 1W
DC	Direct Current
DFS	Dynamic Frequency Selection
DMO	Dynamic Modulation Order
DSSS	Direct Sequence Spread Spectrum
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
emf	electromotive force
ERC	European Radiocommunications Committee
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
EU	European Union
EUT	Equipment Under Test
FCC	Federal Communications Commission
FER	Frame Error Rate
FHSS	Frequency Hopping Spread Spectrum
FM	Frequency Modulation
FSK	Frequency Shift Keying
FSS	Fixed Satellite Service
g	Grams
GHz	GigaHertz
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
ISED	Innovation Science and Economic Development
ITU	International Telecommunications Union
KDB	Knowledge DataBase

kg	kilogram	pW	picoWatts
kHz	kiloHertz	QAM	Quadrature Amplitude Modulation
kPa	Kilopascal	QP	Quasi Peak
LBT	Listen Before Talk	QPSK	Quadrature Phase Shift Keying
LISN	Line Impedance Stabilisation Network	RBW	Resoution Band Width
LNA	Low Noise Amplifier	RED	Radio Equipment Directive
LNB	Low Noise Block	R&TTE	Radio and Telecommunication Terminal Equipment
LO	Local Oscillator	Ref	Reference
m	metre	RF	Radio Frequency
mA	milliAmps	RFC	Remote Frequency Control
max	maximum	RFID	Radio Frequency IDentification
Mbit/s	MegaBits per second	RLAN	Radio Local Area Network
MCS	Modulation and Coding Scheme	RMS	Root Mean Square
MHz	MegaHertz	RNSS	Radio Navigation Satellite Service
mic	Microphone	RSL	Received Signal Level
MIMO	Multiple Input, Multiple Output	RSSI	Received Signal Strength Indicator
min	minimum	RTP	Room Temperature and Pressure
mm	millimetres	RTPC	Remote Transmit Power Control
ms	milliseconds	Rx	Receiver
mW	milliWatts	s	Seconds
NA	Not Applicable	SINAD	Signal to Noise And Distortion
NFC	Near Field Communications	SRD	Short Range Device
nom	Nominal	Tx	Transmitter
nW	nanoWatt	UKAS	United Kingdom Accreditation Service
OATS	Open Area Test Site	UKCA	United Kingdom Conformity Assessed
OBW	Occupied Band Width	UKRER	United Kingdom Radio Equipment Regulations
OCW	Occupied Channel Width	UHF	Ultra High Frequency
OFDM	Orthogonal Frequency Division Multiplexing	U-NII	Unlicensed National Information Infrastructure
OOB	Out Of Band	USB	Universal Serial Bus
ppm	Parts per million	UWB	Ultra Wide Band
PER	Packet Error Rate	V	Volts
PK	Peak	V/m	Volts per metre
PMR	Private Mobile Radio	VBW	Video Band Width
PRBS	Pseudo Random Bit Sequence	VHF	Very High Frequency
PRF	Pulse Repitition Frequency	VSAT	Very Small Aperture Terminal
PSD	Power Spectral Density	W	Watts
PSU	Power Supply Unit		

====== END OF TEST REPORT ======